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ANNUAL REPORT

OF THE

SECRETARY OF WAR

FOR

THE YEAR 1886.

IN FOUR VOLUMES.

VOLUME II.

PART 2.

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ERRATA FOR ANNUAL REPORT OF THE CHIEF OF ENGINEERS, U. S. ARMY, FOR 1886.

Page 541.—Heading Improvement of navigation in the Back Cove, Portsmouth Harbor, New Hampshire, should read— Improvement of navigation in the channel of Back Cove, Portland, Maine.

Page 555.—In estimate, fourth line, change $2 to $1

Page 1161.—First line, after the word presumably, insert interested

Page 1165.—Fourth line from bottom, change 30 feet to 80 feet

Page 1171.—Paragraph 2, first line change 1870 to 1876,

Page 1176.—Seventh line from bottom, change 4 to 5

Page 1208.—Fifteenth line from bottom, change $15,154.83 to $15,164.83.

Page 1230.—Third paragraph from bottom, third line, change those short crises to three short rises

Page 1231.—Second table, 6th column, box heading, 29 feet should be 26 feet

First table, 9th column, box heading 29 feet should be 26 feet

Page 1246.—Ending fourth paragraph insert, Major Stickney in his report of 1884, saying "the detailed plans for locks not being completed, no new estimate is presented, but it is probable that the cost of such locks as are deemed suitable for the work will increase the estimate somewhat."

Page 1252.—End of fourteenth line, change 0.0 feet to 0.05 feet

Fifteenth line, change 8.5 to .85

Twenty-first line, change 25 to .25

Page 1257.—Last paragraph, second line, change 74.07 to 7,407

Page 1258.—Ninth line, change feet to inch

Page 1263.—To follow improvement of bayou Courtableau, Louisiana, insert:

Appropriations for this work have been as follows:

June 14, 1880	$7,500
March 3, 1881	7,500
July 5, 1884	4,000
Total	19,000.

Page 1267.—Fifth paragraph, third line, change $100,000 to $109,000;

Page 1274.—Fifth paragraph, second line, change instrument to investment.

Page 1277.—Fourth paragraph, eleventh line, be subjected should be not subjected.

Page 1278.—Fourth paragraph, sixth line, change 188.40 to 10,840

Eighth paragraph, seventh line, change rest to crest

Page 1279.—Sixth paragraph, fourth line, change 664,364 to 66,436.4

Page 1283.—For last paragraph insert:

Generally considered there has been a deepening since 1881 of from 1 to 2½ feet over the whole area between the jetties, the greatest scour having taken place in the deepest water. The improvement in depth has extended for a distance of 2,000 feet beyond the end of the east jetty, though to a less degree than within. Beyond this there is a small area where no change has occurred, while beyond this again there has been a shoaling of four-tenths of a foot in the line of the channel and out to a depth of 12 feet.

Behind the west jetty the water has shoaled from 1 to 4 feet, the greatest shoaling being found near the shore. From a point 1,000 feet beyond the "Clifton" and between the new channel and the foundation of the west jetty, laid in 1883, there has been a shoaling which extends out to the 12-foot depth. The decrease in depth is greatest near the jetty, and diminishes gradually toward the eastward. The bottom over this area is hard sand, and it is evident that the shoaling has been due to the banking up of the westerly sand-drift against the west jetty; for in 1884 this sand bottom was found to extend 1¼ miles to the eastward of the west jetty, while now sand is only found in isolated spots farther to the eastward than 1,800 feet from the west jetty, and at certain points it completely covers the foundation and has overflowed to the west of the jetty.

Page 1284.—Omit paragraph (second from bottom) beginning with Behind the west jetty, &c.
Page 1287.—Fourth paragraph, second line, change 700 to 7,000
Page 1325.—Fifth and sixth lines, change $14,451 to $14,541
Page 1327.—Four lines from bottom, change 720 to 750
Page 1329.—Fourth paragraph, fourth line, change 4,027,636 to 4,027.636.
Fourth paragraph, seventh line, change 14,566,616 to 14,566.616.
Page 1332.—Fifth paragraph, third line, change station No. 1 to station No. 4
Page 1334.—Under heading Improvement of Harbor at Brazos Santiago, Texas, change appropriated 1885–'86 to appropriated 1880-'86
Page 1341.—Paragraph next to the last, second line, change 1885 to 1884
Page 1342.—Fortieth line, change 727,049.10 to 725,049.10
Page 1344.—Paragraph 2, tenth line, change drains to draws
Page 1345.—Paragraph 6, sixteenth line, change 1879 to 1877
Page 1358.—Under commercial statistics, after the words lumber and timber feet B. M., change 100,000 to 1,100,000
Page 1363.—Six lines from bottom, change 1880 to 1883.
Page 1372.—Paragraph 5, eleventh line, change two hundred and thirty to three hundred and twenty
Page 1400.—Paragraph 5, last line, change $12,000 to $2,000.
Page 1421.—Above money statement insert:

ABSTRACT OF APPROPRIATIONS.

By act approved June 18, 1878	$250,000
By act approved March 3, 1879*	100,000
By act approved June 14, 1880	150,000
By act approved March 3, 1881	200,000
By act passed August 2, 1882	250,000
By act approved July 5, 1884	250,000
Total	1,200,000

Page 1422.—Eleventh line from bottom change 4 to 3
Page 1447.—Third paragraph, ninth line, change 1854 to 1864,
Page 1451.—Sixth paragraph, sixth line, after cubic yard insert of rock
Page 1455.—Last paragraph, first line, change Dutch to Duck
Page 1461.—First table, fifth column, opposite 1880, insert $4
First table, sixth column, opposite 1880, change $52,052.00 to $6,052.00
Page 1462.—Second table, second column, fifth line, change 6,397.50 to 3,697.50
Page 1463.—Under the head of *Comparison of estimates*, &c., eighth column, fourth line, change 8,968.98 to 8,986.98
Page 1491.—Immediately above the last line insert expended during the fiscal year ending June 30, 1886, including outstanding liabilities, $2,469.46.
Page 1551.—Contract was awarded to John J. Shipman, and was executed under date of September 26, 1885, transpose to precede A A 12.
Page 1594.—Fourth paragraph, second line, change Dano to Dana
Page 1595.—Eighth paragraph after Schoonmaker change chief to civil
Eighth paragraph, end of fourth line, insert the
Second paragraph from bottom, second line, after guard insert crib
Page 1596.—To follow seventh paragraph: The following is from the records kept at the lock for the year.
Ninth paragraph from bottom, second line, between the words up and the insert till
Fifth paragraph from bottom, second line, change lowering to lowered
Page 1597.—Fifth line, change 2,426,300 to 3,426,300
Seventh paragraph from bottom, third line, after the word anything insert of importance
Page 1598.—Fourth paragraph, first line, change belted to bolted
Fifth paragraph, first line, change Kiolin to Kirlin
Beginning seventh paragraph, change for several to the several
Page 1613.—Last line, change 73.2 to 32.7
Page 1614.—Second paragraph, second line, after the word water insert It was maintained 250 days to lock No. 5, and was suspended 47 days by ice and high water,

---

* Twenty thousand dollars set aside for testing Adam's Flume.

Page 1614.—Fifth paragraph, third line, between the and lowest insert next to the

Page 1620.—Third table, fourth column, first line, change $744,400 to $774,400

Page 1635.—Eighth paragraph, fifth line, change $5,726.52 to $6,726.52.

Page 1638.—Fourth paragraph, fourth line, insert . feet after 6 and inches after 12

Page 1697.—Last paragraph, first line, change 2.8 inches to 2 feet 8 inches

Page 1705.—Between twenty-fifth and twenty sixth lines insert Coal shipped out by rail, cars 2,409

Page 1762.—Last paragraph, first line, change 1886 to 1866.

Page 1764.—In first paragraph, under heading "Improvement of Muskegon Harbor, Michigan," change the word stream to channel in first line.

Page 1767.—Fourth paragraph from bottom, third line, change 45 to 4.5

Page 1768.—Third paragraph from bottom, last line, after 1868, insert 1869, end crib and after condition insert 123 feet crib work of irregular width built previous to 1866, re-superstructured in 1884, in good condition, and 46 feet of crib work 20 feet wide, built in 1868, re-superstructed in 1884, in good condition.

Page 1769.—Eighth paragraph, change 1886 to 1866

Page 1774.—Second paragraph, fourth line, change 90 feet to 30 feet

Page 1778.—Ninth paragraph, fourth line, after the words paid for insert leaving 46,527 cubic yards which was paid for

Page 1781.—Under Money Statement, tenth line, to follow project, insert modified as proposed

Page 1783.—In second table, third box-heading, Hercules powder, change 1,000 pounds to 4,000 pounds.

Page 1792.—Next to last line, change 1856 to 1855,

Page 1794.—Second paragraph, third line, change 1866 to 1868
Fourth paragraph, seventh line, change the slopes to side slopes

Page 1796.—Eighth paragraph, second line, change 1881 to 1871

Page 1801.—Third paragraph, second line, change constructed to obstructed

Page 1802.—Fifth paragraph, seventh line, after practically insert completed

Page 1823.—Sixth line from bottom, change 223,872 to 323,872

Page 1824.—Fourth line from bottom, change 58,000 to 85,000

Page 1833.—Second table, abstract of bids for supplies opened April 2, 1886, should be as follows:

Abstracts of bids for supplies required for the harbor of refuge, Lake Huron, received and opened by Lieut. Col. O. M. Poe, Corps of Engineers, on April 2, 1886, in accordance with advertisement dated March 23, 1886.

No.	Names and residences of bidders.	Painters' supplies.	Ship chandlery.	Hardware.
1	H. D. Edwards & Co., Detroit, Mich *	$45 81		
2	Farrand Williams & Co., Detroit, Mich	50 36		
3	J. P. Donaldson & Co., Detroit, Mich	52 10		
4	T. H. Hinchman & Son, Detroit, Mich	54 20		
5	James E. Davis & Co., Detroit, Mich	54 02		
1	H. D. Edwards & Co., Detroit, Mich *		$183 45	
2	J. P. Donaldson & Co., Detroit, Mich		198 50	
1	James L. Fisher, Detroit, Mich *			$42 35
2	T. B. Rayl & Co., Detroit, Mich			44 50

* Recommended for acceptance.

Page 1836.—Fourth paragraph from bottom, change 20,000 to 20

Page 1860.—Seventh paragraph, second line, change $114,133.64 to $114,183.64

Page 1872.—In abstract of contract, second column, third, fourth, and fifth lines, between the words per and foot insert M

Page 1884.—Under second heading Commercial Statistics, amount of revenue collected should be $156,663.71

Page 1891.—Sixth paragraph from bottom, fourth line, change 1886 to 1885,
Fourth paragraph from bottom, change 500 to 568

Page 1893.—Third paragraph, fourth line, after pier head. insert in 1869

CONTENTS.

[Alphabetical Index will be found at the end of each Part.]

PART I.

Officers of the Corps of Engineers 3

SEA-COAST AND LAKE FRONTIER DEFENSES.

General discussion 4

Estimates of Appropriations for 1887-'88 5

Northern Frontier.—Ft. Wayne, Mich., 5; Ft. Porter, N. Y., Ft. Niagara, N. Y., 6; Ft. Ontario, N. Y., Ft. Montgomery, N. Y., 7. The Penobscot, Me.—Ft. Knox, 7. The Kennebec, Me.—Ft. Popham, 8. Portland, Me.—Ft. Gorges, Ft. Preble, 8; Ft. Scammel, battery on Portland Head, 9; batteries on Cow Id., batteries on Great Hog Id., 10. Portsmouth, N. H., and Navy-Yard at Kittery, Me.—Ft. McClary, Ft. Constitution, 10; battery on Gerrish's Id., battery on Jerry's Point, 11. Boston and Navy-Yard at Charlestown, Mass.—Ft. Warren, battery at Long Id. Head, Ft. Winthrop, 12; Ft. Independence, 13. New Bedford, Mass.—Fort at Clark's Point, 14. Narragansett Bay, R. I.—Ft. Adams, 14; defenses of Dutch Id., 15. New London Harbor and Navy-Yard, Conn.—Ft. Trumbull, 15; Ft. Griswold, 16. New Haven, Conn.—Ft. Hale, 17. New York and Navy-Yard at Brooklyn.—Ft. Schuyler, fort at Willets Point, 17; defenses of Governor's Id., sea-wall on Governor's Id., 18; Ft. Wood, Ft. Hamilton and additional batteries, 19; mortar battery at Ft. Hamilton, Ft. Lafayette, Ft. Wadsworth, 20; fort on site of Ft. Tompkins, Glacis Gun Battery (n. of fort on site of Ft. Tompkins), 21; Glacis Mortar Battery (s. of fort on site of Ft. Tompkins), Battery Hudson, 22; South Mortar Battery, North Cliff Battery, 23; South Cliff Battery, Two-gun Battery near fort on site of Ft. Tompkins, fort at Sandy Hook, 24. Philadelphia and League Island Navy-Yard.—Ft. Mifflin, mortar battery at Ft. Mifflin, 25; site for defenses at Red Bank, Ft. Delaware, 26; battery at Finn's Point, mortar battery at Finn's Point, fort opposite Ft. Delaware, 27; mortar battery opposite Ft. Delaware, 28. Baltimore, Md.—Ft. McHenry, 28; Ft. Carroll, 29. Washington, D. C.—Ft. Foote, 29; Ft. Washington, obstructions of the Potomac, 30. Hampton Roads and Gosport Navy-Yard, Va.—Ft. Monroe, 30; artesian well at Ft. Monroe, Ft. Wool, 32. Beaufort Harbor, N. C.—Ft. Macon, 33. Wilmington, N. C. Ft. Caswell, 34. Charleston, S. C.—Ft. Moultrie, Ft. Sumter, 34; Ft. Johnson, 35; Castle Pinckney, 36. Savannah, Ga.—Ft. Oglethorpe, Ft. Pulaski, 36; new fort on Tybee Id., 37. Cumberland Sound.—Ft. Clinch, 37. Saint Augustine, Fla.—Ft. Marion, 38. Key West, Fla.—Ft. Taylor and batteries, 38. Harbor of Dry Tortugas, Fla.—Ft. Jefferson, 39. Pensacola Harbor and Navy-Yard, Fla.—Ft. Pickens, Ft. Barrancas and redoubt, 40; Ft. McRee, 41. Mobile, Ala.—Ft. Morgan, Ft. Gaines, 41. Mississippi Sound.—Fort on Ship Island, 42. New Orleans, La.—Ft. Pike, 42; Ft. Macomb, Tower Dupré, Battery Bienvenue, tower at Proctorsville, 43; Ft. Jackson, Ft. St. Philip, Ft. Livingston, 44. Galveston, Tex.—Batteries at the entrance to the harbor of Galveston, 45. San Diego Harbor, California.—Fort at San Diego, 45. San Francisco, Navy-Yard at Mare Island, and Arsenal at Benicia, Cal.—Ft. Winfield Scott, 45; fort at Lime Point, 46; fort on Alcatraz Id., Ft. Mason, batteries on Angel Id., 47. Defenses of the Columbia, Oreg., and Wash.—Ft. Stevens, Ft. Canby, 47.

THE BOARD OF ENGINEERS.

Officers constituting Board, Fortifications, 49; *Rivers and Harbors*, 49; *Coast defenses, Torpedo defense*, 50; *Estimate for service of torpedoes*, 51.

POST OF WILLETS POINT AND ENGINEER SCHOOL OF APPLICATION.. 52
BATTALION OF ENGINEERS AND DEPOT AT WILLETS POINT, NEW YORK HARBOR 53

RIVER AND HARBOR IMPROVEMENTS.

General statement 53

ATLANTIC COAST AND GULF OF MEXICO.

In charge of Maj. Jared A. Smith, Corps of Engineers—

Lubec Channel, Me., 54; Bangor Harbor and Penobscot River, Me., Moose-a-bec Bar, Me., 55; Belfast Harbor, Me., Rockland Harbor, Me., 56; Portland Harbor, Me., Kennebunk River, Me., 57; breakwater at mouth of Saco River, Me., Saco River, Me., Portsmouth Harbor, N. H., 58; Cocheco River, N. H., harbor of refuge at Little Harbor, N. H., 59; examination and survey, 60.

In charge of Maj. George L. Gillespie, Corps of Engineers—

Newburyport Harbor, Mass., 60; Merrimac River, Mass., 61; Scituate Harbor, Mass., 62; Boston Harbor, Mass., 63; Plymouth Harbor, Mass., 64; Provincetown Harbor, Mass., Lynn Harbor, Mass., 65; Malden River, Mass., 66; harbor of refuge at Sandy Bay, Cape Ann, Mass., 67.

In charge of Lieut. Col. George H. Elliot, Corps of Engineers—

Harbor of refuge at Hyannis, Mass., harbor of refuge at Nantucket, Mass., 68; Woods Holl Harbor, Mass., 69; Westport Harbor, Mass., Wareham Harbor, Mass., 70; Taunton River, Mass., 72; Pawtucket River, R. I., 73; Providence River and Narragansett Bay, R. I., 74; Green Jacket Shoal, Providence River, R. I., Warren River. R. I., Newport Harbor, R. I., 75; harbor of refuge at Block Island, R. I., 77; Little Narragansett Bay, R. I., harbor of refuge at Stonington., Conn., 78; Pawcatuck River, R. I., and Conn., removing sunken vessels or craft obstructing or endangering navigation, 80.

In charge of Lieut. Col. D. C. Houston, Corps of Engineers—

Connecticut River, Mass. and Conn., 81; Thames River, Conn., 82; New London Harbor, Conn., Clinton Harbor, Conn., 83; New Haven Harbor, Conn., Breakwater at New Haven, Conn., 84; Milford Harbor, Conn., Housatonic River, Conn., 85; Bridgeport Harbor, Conn., 86; Black Rock Harbor, Conn., Southport Harbor, Conn., 87; Norwalk Harbor, Conn., Port Chester Harbor, N. Y., 88; New Rochelle Harbor, N. Y., Echo Harbor, New Rochelle, N. Y., 89; Mamaroneck Harbor, N. Y., Greenport Harbor, N. Y., Port Jefferson Harbor, N. Y., 90; Flushing Bay, N. Y., East Chester Creek, N. Y., 91.

In charge of Lieut. Col. Walter McFarland, Corps of Engineers—

Hudson River, N. Y., 92; harbor at Saugerties, N. Y., 93; harbor at Rondout, N. Y., Harlem River, N. Y., 94; removing obstructions in East River and Hell Gate, N. Y., 95; Newtown Creek, N. Y., 96; Buttermilk Channel, N. Y., 97; Gowanus Bay, N. Y., Gedney's Channel, N. Y., 98; Sheepshead Bay, N. Y., 100; Canarsie Bay, N. Y., 101; Sumpawanus Inlet, N. Y., Manasquan River, N. J., 102; Shrewsbury River, N. J., 103; harbor at Keyport, N. J., Mattawan Creek, N. J., 105; Cheesequakes Creek, N. J., Raritan Bay, N. J., 106; Raritan River, N. J., 107; South River, N. J., 108; Woodbridge Creek, N. J., Rahway River, N. J., 109; Elizabeth River, N. J., channel between Staten Island and New Jersey, 110; Passaic River, N. J., 111.

In charge of Lieut. Col. Henry M. Robert, Corps of Engineers—

Delaware River from Trenton, N. J., to its mouth, 113; Delaware River at Schooner Ledge, Delaware River near Cherry Island Flats, 115; Frankford Creek, Pa., Schuylkill River, Pa., 116; ice-harbor at Marcus Hook, Pa., 117; ice-harbor at the head of Delaware Bay, Del., construction of iron pier in Delaware Bay, near Lewes, Del., 118; Delaware Breakwater Harbor, Del., 119; Rancocas River, N. J., 120; Woodbury Creek, N. J., Mantua Creek, N. J., Raccoon River, N. J., 121; Salem River, N. J., Cohansey Creek, N. J., 122; removal of wrecks from Delaware Bay and River, removing sunken vessels or craft obstructing or endangering navigation, United States commission advisory to the board of harbor commissioners of Philadelphia, Pa., 123.

In charge of Mr. William F. Smith, U. S. Agent—

Maurice River, N. J., Wilmington Harbor, Del., 124; ice-harbor at New Castle, Del., 125; Duck Creek, Del., Saint Jones River, Del., 126; Mispillion Creek, Del., 127; Broadkiln River, Del., Broad Creek, Del., from its mouth to Laurel, 128; Indian River, Del., Susquehanna River above and below Havre de Grace, Md., 129; Chester River at Kent Island Narrows, Md., Chester River from Spry's Landing to Crumpton, Md., 130; Corsica Creek, Md., Choptank River, Md., 131; Wicomico River, Md., Upper Thoroughfare, between Deil's Island and the mainland, Md., 132.

In charge of Lieut. Col. William P. Craighill, Corps of Engineers—

Patapsco River and channel leading to Baltimore, Md., 133; harbor at Annapolis, Md., 134; removing sunken vessels or craft obstructing or endangering navigation, 135.

In charge of Maj. Peter C. Hains, Corps of Engineers, Bvt. Lieut. Col., U. S. A.—

Harbors at Washington and Georgetown, D. C., 135; Potomac River at Washington, D. C., 136; James River, Va., 137; Shenandoah River, W. Va., 139.

In charge of Mr. S. T. Abert, U. S. Agent—

Channel at Mount Vernon, Va., 139; Neabsco Creek, Va.; Breton Bay, Leonardtown, Md., 140; Nomini Creek, Va.; harbor at entrance of Saint Jerome's Creek, Md., 141; Rappahannock River, Va.; Totusky River, Va., 142; Urbana Creek, Va.; Mattaponi River, Va., 143; Pamunky River, Va.; York River, Va., 144; Chickahominy River, Va., 145; Staunton River, Va., 145, 146; Dan River, between Madison, N. C., and Danville, Va., 146; Roanoke River, N. C.; French Broad River, N. C., 147; examination aqueduct bridge, 148.

In charge of Capt. F. A. Hinman, Corps of Engineers—

Harbor at Norfolk, Va., 148; approach to Norfolk Harbor and the (Norfolk) Navy-Yard, between Lambert's Point and Fort Norfolk, Va., 149; Appomattox River, Va., 150; Nottaway River, Va., 151; Blackwater River, Va., Archer's Hope River, Va., 152; North Landing River, Va. and N. C., 153; Edenton Bay, N. C., Currituck Sound, Coanjok Bay, and North River Bar, N. C., 154; Meherrin River, N. C., 155; Pamplico and Tar rivers, N. C., 156; Yadkin River, N. C., 157; Scuppernong River, N. C., 158; removing sunken vessels or craft obstructing or endangering navigation, 159.

In charge of Capt. William H. Bixby, Corps of Engineers—

Contentnea Creek, N. C., 159; Trent River, N. C., 160; Neuse River, N. C., 162; inland navigation from New Berne to Beaufort Harbor, via Clubfoot, Harlowe, and Newport rivers, N. C., 163; harbor at Beaufort, N. C., 164; New River, N. C., 165; Cape Fear River, above Wilmington, N. C., 166; Cape Fear River, below Wilmington, N. C., 168; Great Pe Dee River, S. C., 169; Waccamaw River, S. C., 170; harbor at Georgetown, S. C., 172; Santee River, S. C., 173; Wateree River, S. C., 174; removing sunken vessels obstructing or endangering navigation, 175.

In charge of Col. Q. A. Gillmore, Corps of Engineers, Bvt. Maj. Gen., U. S. A.—

Charleston Harbor, S. C., 176; Wappoo Cut, S. C., 178; Ashley River, S. C., Edisto River, S. C., 179; Salkiehatchie River, S. C., 180; Savannah Harbor and River, Ga., 181; Savannah River, Ga., 183; Savannah River above Augusta, Ga., 184; Saint Augustine Creek (Thunderbolt River), Ga., Romerly Marsh, Ga., 185; Altamaha River, Ga., 186; Brunswick Harbor, Ga., 187; entrance to Cumberland Sound, Ga. and Fla., 189; inside passage between Fernandina and Saint John's River, Fla., 190.

In charge of First Lieut. Wm. M. Black, Corps of Engineers—

Saint John's River, Fla., 190; Upper Saint John's River, Fla., 191; Volusia Bar, Fla., Tampa Bay, Fla., 192; Apalachicola Bay, Fla., 193; Suwanee River, Fla., Key West Harbor, Fla., 194; Pease Creek, Fla., harbor at Cedar Keys, Fla., Manatee River, Fla., 195; Caloosahatchie River, Fla., Apalachicola River, Fla., 196; Withlacoochee River, Fla., removing sunken vessels or craft obstructing or endangering navigation, 197.

IN CHARGE OF CAPT. R. L. HOXIE, CORPS OF ENGINEERS—

Ocmulgee River, Ga., Oconee River, Ga., 198; Flint River, Ga., Oostenaula and Coosawattee rivers, Ga., 199; Coosa River, Ga. and Ala., Chattahoochee River, Ga. and Ala., 200; Alabama River, Ala., Tallapoosa River, Ala., 201; Cahaba River, Ala., 202; Conecuh—Escambia River, Fla. and Ala., Choctawhatchee River, Fla. and Ala., 203; Bayou La Grange, Fla., harbor at Pensacola, Fla, 204.

IN CHARGE OF MAJ. A. N. DAMRELL, CORPS OF ENGINEERS—

Mobile Harbor, Ala., 205; Warrior River, Ala., Tombigbee River, from Fulton to Vienna, 206; Tombigbee River, below Vienna, 207; Black Warrior River, from Tuscaloosa to Daniel's Creek, Ala., Old Town Creek, Miss., Noxubee River, Miss., 208; Pascagoula River, Miss., harbor at Biloxi Bay, Miss., 209; Horn Island Pass, Miss., Pearl River, Miss., below Jackson, Pearl River, Miss., from Jackson to Carthage, 210; Pearl River, Miss., between Edinburg and Carthage, 211; examinations and surveys, 211.

IN CHARGE OF MAJ. W. H. HEUER, CORPS OF ENGINEERS—

Inspection of the improvement at the South Pass of the Mississippi River, 212; Amite River, La., Tangipahoa River, La., 213; Tchefuncte River, La., 214; Tickfaw River, La., Bayou Teche, La., 215; connecting Bayou Teche with Grand Lake at Charenton, La., 216; Bayou Black, La., 217; Bayou Courtableau, La., 218; Bayou Terrebonne, La., Bayou La Fourche, La., 219; Calcasieu River, La., Calcasieu Pass, La., 220; Sabine Pass, Tex., 221; Sabine River, La. and Tex., Neches River, Tex., 222; removing sunken vessel or craft obstructing or endangering navigation, 223.

IN CHARGE OF MAJ. S. M. MANSFIELD, CORPS OF ENGINEERS, BVT. LIEUT. COL., U. S. A.—

Entrance to Galveston Harbor, Tex., 223; ship-channel in Galveston Bay, Tex., Trinity River, Tex., 224; Buffalo Bayou, Tex., channel over the bar at the mouth of Brazos River, Tex., Pass Cavado Inlet, to Matagorda Bay, Tex., 225; Aransas Pass and Bay, up to Rockport and Corpus Christi, Tex., harbor at Brazos Santiago, Tex., 226; protection of river-bank at Fort Brown, Tex., 227.

WESTERN RIVERS.

IN CHARGE OF CAPT. ERIC BERGLAND, CORPS OF ENGINEERS—

Red River, La. and Ark., 227; survey of Bayou Pierre, La., Cypress Bayou, Tex. and La., 229; Cane River, La., Loggy Bayou, Lake Bisteneau, and the Dorcheat, La., Ouachita and Black rivers, Ark. and La., 230; Bayou Bartholomew, La. and Ark., Bayou Bœuf, La., 231; Tensas River and Bayou Macon, La., Bayou D'Arbonne, La., 232; Yazoo River, Miss., 233; Big Sunflower River, Miss., Tchula Lake, Miss., Tallahatchee River, Miss., 234; Yallabusha River, Miss., Steele's Bayou, Miss., 235; Big Black River, Miss., Big Hatchee River, Tenn., 236; South Forked Deer River, Tenn., water-gauges on the Mississippi River and it principal tributaries, 237.

IN CHARGE OF CAPT. H. S. TABER, CORPS OF ENGINEERS—

Removing obstructions in Arkansas River, Ark., Arkansas River at Pine Bluff, Ark., 238; Black River, Ark. and Mo., White River, Ark., 240; White River, above Buffalo Shoals, Ark., 241; Saint Francis River, 242; Saline River, Ark., L'Anguille River, Ark., 243; surveys, 244.

IN CHARGE OF MAJ. A. M. MILLER, CORPS OF ENGINEERS—

Removing snags and wrecks from the Mississippi and Missouri rivers, 244; Osage River, Kans. and Mo., 246; Gasconade River, Mo., 247.

MISSISSIPPI RIVER COMMISSION 247

MISSOURI RIVER COMMISSION 248

IN CHARGE OF CAPT. C. B. SEARS, CORPS OF ENGINEERS—

Improvement of the Missouri River from Sioux City, Iowa, to Fort Benton, Mont., 248.

IN CHARGE OF CAPT. JAMES B. QUINN, CORPS OF ENGINEERS—

Improvement of Yellowstone River, Mont. and Dak., 249.

In charge of Maj. O. H. Ernst, Corps of Engineers—

Improvement of the Mississippi River from the mouth of the Illinois to the mouth of the Ohio, 249.

In charge of Capt. E. H. Ruffner, Corps of Engineers—

Improvement of the Mississippi River from Des Moines Rapids to the mouth of Illinois River, 249.

In charge of Maj. Alexander Mackenzie, Corps of Engineers—

Upper Mississippi River, operations of snag-boats and dredge-boats, Mississippi River from Saint Paul to Des Moines Rapids, 250; Mississippi River from Des Moines Rapids to mouth of the Illinois River, harbor of refuge in Lake Pepin, at Stockholm, Wis., harbor of refuge in Lake Pepin, at Lake City, Minn., 251; removal of bar in Mississippi River opposite Dubuque, Iowa, ice-harbor at Dubuque, Iowa, Rock Island Rapids, Mississippi River, 252; Des Moines Rapids, Mississippi River, 253; operating and care of Des Moines Rapids Canal, dry-dock at Des Moines Rapids Canal, 254.

In charge of Maj. Charles J. Allen, Corps of Engineers—

Preservation of Falls of Saint Anthony, Minn., 255; Mississippi River above the Falls of Saint Anthony, Minn., 256; construction of lock and dam on Mississippi River at Meeker's Island, Minn., 257; Chippewa River, Wis., 258; Chippewa River at Yellow Banks, Wis., Saint Croix River below Taylor's Falls, Minn. and Wis., 259; Minnesota River, Minn., 260; Red River of the North, Minn. and Dak., 261; lock and dam at Goose Rapids on Red River of the North, Minn. and Dak., 262; reservoirs upon the headwaters of the Mississippi River, 263; surveys for reservoirs at the sources of the Mississippi, Saint Croix, Chippewa, and Wisconsin rivers, 264.

In charge of Lieut. Col. J. W. Barlow, Corps of Engineers—

Tennessee River, 264; Cumberland River, 266; Hiawassee River, 267; French Broad River, Tenn., Clinch River, Tenn., 268; Duck River, Tenn., Caney Fork River, Tenn., 269; Little Tennessee River, Tenn., South Fork Cumberland River, Ky., 270.

In charge of Lieut. Col. William E. Merrill, Corps of Engineers, Bvt. Col., U. S. A.—

Ohio River, 271; operating and care of Davis Island Dam, Ohio River, 272; Monongahela River, W. Va., and Pa., operating and care of Lock and Dam No. 9, Monongahela River, Allegheny River, Pa., dam at Herr's Island, Allegheny River, 273; ice-harbor at mouth of Muskingum River, Ohio, Muskingum River, Ohio, 274; operating and care of locks and dams on the Muskingum River, Ohio, harbor of refuge near Cincinnati, Ohio, harbor of refuge at mouth of Great Kanawha River, W. Va., 275; examination and survey, 276.

In charge of Major Amos Stickney, Corps of Engineers—

Falls of the Ohio River at Louisville, Ky., Indiana Chute, Falls of the Ohio River, 276; Louisville and Portland Canal, Wabash River, Ind. and Ill., 277; White River, Ind., 279.

In charge of Lieut. Col. W. P. Craighill, Corps of Engineers—

Great Kanawha River, W. Va., 279; Elk River, W. Va.; New River, from the mouth of Wilson, in Grayson County, Va., to the mouth of Greenbrier River, W. Va., 281.

In charge of Capt. James C. Post, Corps of Engineers—

Kentucky River, Ky., 282; operating and keeping in repair locks and dams on the Kentucky River, Ky., 283; Tradewater River, Ky., Big Sandy River, W. Va. and Ky., 284; Guyandotte River, W. Va., Little Kanawha River, W. Va., 285; Buckhannon River, W. Va., 286.

LAKE HARBORS AND RIVERS.

In charge of Maj. Charles J. Allen, Corps of Engineers—

Harbor at Duluth, Minn., 287; dredging Superior Bay, Wis., 288; harbor at Grand Marais, Minn., 289.

In charge of Capt. Charles E. L. B. Davis, Corps of Engineers—

Ontonagon Harbor, Mich., 290; Eagle Harbor, Mich., Marquette harbor, Mich., 291; harbor of refuge at Grand Marais, Mich., 292; Manistique Harbor, Mich., harbor at mouth of Cedar River, Mich, 293; Menomonee Harbor, Mich. and Wis., Oconto Harbor, Wis., 294; Pensaukee Harbor, Wis., 295; Green Bay Harbor, Wis., harbor of refuge at entrance of Sturgeon Bay Canal, Wis., 296; Ahnepee Harbor, Wis., Kewaunee Harbor, Wis., 297; Two Rivers Harbor, Wis., 298; Manitowoc Harbor, Wis., Sheboygan Harbor, Wis., 299; Port Washington Harbor, Wis., 300; survey, 301.

In charge of Capt. W. L. Marshall, Corps of Engineers—

Harbor of refuge, Milwaukee Bay, Wis., 301; Milwaukee Harbor, Wis., Racine Harbor, Wis., 302; Kenosha Harbor, Wis., Waukegan Harbor, Ill., 303; Fox and Wisconsin rivers, Wis., 304.

In charge of Maj. W. H. H. Benyaurd, Corps of Engineers—

Chicago Harbor, Ill., 306; Calumet Harbor, Ill., 307; Illinois River, Calumet River, 308; survey, 309.

In charge of Capt. D. W. Lockwood, Corps of Engineers—

Charlevoix Harbor, Mich, 309; Frankfort Harbor, Mich., harbor of refuge at Portage Lake, Mich., 310; Manistee Harbor, Mich., 311; Ludington Harbor, Mich., Pentwater Harbor, Mich., 312; White River Harbor, Mich., Muskegon Harbor, Mich., 313; Grand Haven Harbor, Mich., Grand River, Mich., Black Lake Harbor, Mich., 314; Saugatuck Harbor, Mich., South Haven Harbor, Mich., 315; Saint Joseph Harbor, Mich., Michigan City Harbor, Ind., 316.

In charge of Lieut. Col. O. M. Poe, Corps of Efgineers, Bvt. Brig. Gen., U. S. A.—

Hay Lake Channel, Saint Mary's River, Mich., 318; Saint Mary's Falls Canal and River, Mich., operating and care of Saint Mary's Falls Canal, Mich., 319; dry-dock at Saint Mary's Falls Canal, Mich., harbor at Cheboygan, Mich., 320; harbor at Thunder Bay, Mich., harbor at Au Sable, Mich., 321; Saginaw River Mich., harbor of refuge, Sand Beach, Lake Huron, Mich., 322; steam launch or tug for harbor of refuge, Lake Huron, Mich., 323; ice-harbor of refuge at Belle River, Mich., general repairs and renewals at Saint Clair Flats Ship Canal, Mich., 324; operating and care of Saint Clair Flats Canal, Mich., Clinton River, Mich., 325; Detroit River, Mich., 326.

In charge of Maj. L. Cooper Overman, Corps of Engineers—

Monroe Harbor, Mich., 326; Toledo Harbor, Ohio, 327; Port Clinton Harbor, Ohio, 329; Sandusky City Harbor, Ohio, 330; Sandusky River, Ohio, 331; Huron Harbor, Ohio, Vermillion Harbor, Ohio, 332; mouth of Black River, Ohio, 333; Rocky River, Ohio, Cleveland Harbor, Ohio, 334; Fairport Harbor, Ohio, 336; Ashtabula Harbor, Ohio, 337; Conneaut Harbor, Ohio, Dunkirk Harbor, N. Y., 338; removing sunken vessels or craft obstructing or endangering navigation, 339.

In charge of Capt. Edward Maguire, Corps of Engineers—

Erie Harbor, Pa., 339; Buffalo Harbor, N. Y., 340; Niagara River, N. Y., Wilson Harbor, N. Y., Olcott Harbor, N. Y., 341; Oak Orchard Harbor, N. Y., Charlotte Harbor, N. Y., 342; Pultneyville Harbor, N. Y., 343; Great Sodus Harbor, N. Y., Little Sodus Harbor, N. Y., 344; Oswego Harbor, N. Y., 345; Sackett's Harbor, N. Y., 346.

In charge of Maj. Milton B. Adams, Corps of Engineers—

Ogdensburg Harbor, N. Y., 346; Grass River at Massena, N. Y., 347; breakwater at Rouse's Point, Lake Champlain, N. Y., Swanton Harbor, Vt., Plattsburg Harbor, N. Y., 348; Burlington Harbor, Vt., 349; Otter Creek, Vt., Ticonderoga River, N. Y., 350.

PACIFIC COAST.

In charge of Lieut. Col. George H. Mendell, Corps of Engineers—

Oakland Harbor, Cal., 350; Wilmington Harbor, Cal., 351; Redwood Harbor, Cal., removal of sunken vessels or craft obstructing or endangering navigation, 352.

In charge of Col. C. Seaforth Stewart, Corps of Engineers—

Harbor at San Diego, Cal., 353.

In charge of Capt. A. H. Payson, Corps of Engineers—

Humboldt Harbor and Bay, Cal., 353; San Joaquin River, Stockton and Mormon sloughs, Cal., 354; Mokelumne River, Cal., Sacramento and Feather rivers, Cal., 355; Colorado River, Nevada, Cal., and Ariz., 356.

In charge of Maj. W. A. Jones, Corps of Engineers—

Columbia and Willamette rivers below Portland, Oreg., 357; Upper Willamette River, Oreg.; Columbia River at Cascades, Oreg., 358; Upper Columbia and Snake rivers Oreg. and Wash., Cowlitz River, Wash., 359; Lower Clearwater River, Idaho, 360; examinations and surveys, 360.

In charge of Capt. Charles F. Powell, Corps of Engineers—

Mouth of the Columbia River, Oreg., and Wash., 360; entrance to Coos Bay, Oreg., 361; entrance to Yaquina Bay, Oreg., mouth of Coquille River, Oreg., 362; Umpqua River, Oreg., 363; Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie rivers, Wash., Chehalis River, Wash., 364; gauging waters of the Columbia River and principal tributaries, 365.

EXAMINATIONS, SURVEYS, AND CONTINGENCIES OF RIVERS AND HARBORS.

Estimate for 1887–'88 365

WASHINGTON AQUEDUCT, ETC.

In charge of Maj. G. J. Lydecker, Corps of Engineers—

Washington Aqueduct, 365; increasing the water supply of the city of Washington, 366; erection of fish-ways at the Great Falls of the Potomac River, 368.

PUBLIC BUILDINGS, GROUNDS, ETC., DISTRICT OF COLUMBIA.

In charge of Lieut. Col. John M. Wilson, Corps of Engineers, Colonel, United States Army 368

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

Bridge across the Mississippi River at Keithsburg, Ill., stone-arch bridge across the West Channel of the Mississippi River at Minneapolis, Minn., proposed bridge across the Ohio River at or near Cairo, Ill., 369; bridge of the Selma Bridge Company across the Alabama River at Selma, Ala., changes in the original plan of the bridge across the Ohio River at Henderson, Ky, 370.

PRINTING AND DISTRIBUTION OF CHARTS OF THE NORTHERN AND NORTHWESTERN LAKES 371

MILITARY AND GEOGRAPHICAL MAPS 371

RECONNAISSANCES AND EXPLORATIONS.

Officers on duty at headquarters of the Army, of divisions, and departments, 372; reports made, 372, 373; estimate for surveys and reconnaissances and publications of maps, 373.

OFFICE OF THE CHIEF OF ENGINEERS.

Officers of the Corps of Engineers in charge of divisions 374

STATEMENT OF RANK AND DUTIES OF OFFICERS OF THE CORPS OF ENGINEERS DURING THE FISCAL YEAR................ 375

LAWS AFFECTING THE CORPS OF ENGINEERS, 49TH CONGRESS, 1ST SESSION, 1885-'86........................ 395

FORTIFICATIONS, ETC.

APPENDIX No. 1.

REPORT OF LIEUT. COL. C. B. COMSTOCK, CORPS OF ENGINEERS, BVT. BRIG. GEN., U. S. A.

Post of Willets Point and Engineer School of Application 471

APPENDIX No. 2.

REPORT OF MAJ. W. R. KING, CORPS OF ENGINEERS.

Battalion of Engineers and depot at Willets Point............................ 489

APPENDIX No. 3.

REPORT OF THE BOARD ON FORTIFICATIONS OR OTHER DEFENSES APPOINTED BY THE PRESIDENT OF THE UNITED STATES UNDER THE PROVISIONS OF THE ACT OF CONGRESS APPROVED MARCH 3, 1885. WILLIAM C. ENDICOTT, SECRETARY OF WAR, PRESIDENT 499

RIVERS AND HARBORS, ETC.

APPENDIX A.

REPORT OF MAJ. JARED A. SMITH, CORPS OF ENGINEERS.

IMPROVEMENTS.—Lubec Channel, Me., 527; Bangor Harbor and Penobscot River, Me., 530; Moose-a-bec Bar, Me., 533; Belfast Harbor, Me., 535; Rockland Harbor, Me., 536; Portland Harbor, Me., 538; Kennebunk River, Me., 543; breakwater at mouth of Saco River, Me., 544; Saco River, Me., 546; Portsmouth Harbor, N. H., 546; Cocheco River, N. H., 548; examination and survey Saco River, Me., 552.

APPENDIX B.

REPORT OF MAJ. GEORGE L. GILLESPIE, CORPS OF ENGINEERS, BVT. LIEUT. COL., U. S. A.

IMPROVEMENTS.—Newburyport Harbor, Mass., 557; Merrimac River, Mass., 560; Scituate Harbor, Mass., 562; Boston Harbor, Mass., 564; Plymouth Harbor, Mass., 571; Provincetown Harbor, Mass., 574; Lynn Harbor, Mass., 577; Malden River, Mass., 579; harbor of refuge at Sandy Bay, Cape Ann, Mass., 580.

APPENDIX C.

REPORT OF LIEUT. COL. GEORGE H. ELLIOT, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor of refuge at Hyannis, Mass., 585; harbor of refuge at Nantucket, Mass., 587; Wood's Holl Harbor, Mass., 591; Westport Harbor, Mass., 592; Wareham Harbor, Mass., 593; Taunton River, Mass., 595; Pawtucket River, R. I., 598; Providence River and Narragansett Bay, R. I., 602; Green Jacket Shoal, Providence River, R. I., 605; Warren River, R. I., 605; Newport Harbor, R. I., 606; harbor of refuge at Block Island, R. I., 609; Little Narragansett Bay, R. I. and Conn., 613; harbor of refuge at Stonington, Conn., 614; Pawcatuck River, R. I. and Conn., 616; removing sunken vessels or craft obstructing or endangering navigation, 618.

APPENDIX D.

REPORT OF LIEUT. COL. D. C. HOUSTON, CORPS OF ENGINEERS.

IMPROVEMENTS.—Connecticut River, Mass. and Conn., 623; Thames River, Conn., 629; New London Harbor, Conn., 632; Clinton Harbor, Conn., 634; New Haven Harbor, Conn., 636; Breakwater at New Haven, Conn., 639; Milford Harbor, Conn., 640; Housatonic River, Conn., 642; Bridgeport Harbor, Conn., 644; Black Rock Harbor, Conn., 646; Southport Harbor, Conn., 648; Norwalk Harbor, Conn., 649; Port Chester Harbor, N. Y., 651; New Rochelle Harbor, N. Y., 654; Echo Harbor, New Rochelle, N. Y., 655; Mamaroneck harbor, N. Y., 657; Greenport Harbor, N. Y., 658; Port Jefferson Harbor, N. Y., 660; Flushing Bay, N. Y., 661; East Chester Creek, N. Y., 663.

APPENDIX E.

REPORT OF LIEUT. COL. WALTER McFARLAND, CORPS OF ENGINEERS.

IMPROVEMENTS.—Hudson River, N. Y., 665; harbor at Saugerties, N. Y., 669; harbor at Rondout, N. Y., 670; Harlem River, N. Y., 672; removing obstructions in East River and Hell Gate, N. Y., 675; Newtown Creek, N. Y., 717; Buttermilk Channel, N. Y., 720; Gowanus Bay, N. Y., 722; Gedney's Channel, N. Y., 724; Sheepshead Bay, N. Y., 743; Canarsie Bay, N. Y., 746; Sumpawanus Inlet, N. Y., 748; Manasquan River, N. J., 751; Shrewsbury River, N. J., 756; harbor at Keyport, N. J., 760; Mattawan Creek, N. J., 761; Cheesequakes Creek, N. J., 763; Raritan Bay, N. J., 765; Raritan River, N. J., 769; South River, N. J., 777; Woodbridge Creek, N. J., 781; Rahway River, N. J., 783; Elizabeth River, N. J., 785; channel between Staten Island and New Jersey, 788; Passaic River, N. J., 792.

APPENDIX F.

REPORT OF LIEUT. COL. HENRY M. ROBERT, CORPS OF ENGINEERS.

IMPROVEMENTS.—Delaware River from Trenton, N. J., to its mouth, 801; Delaware River at Schooner Ledge, 828; Delaware River near Cherry Island Flats, 829; Frankford Creek, Pa., 829; Schuylkill River, Pa., 830; ice-harbor at Marcus Hook, Pa., 832; ice-harbor at the head of Delaware Bay, Del., 834; construction of iron pier in Delaware Bay near Lewes, Del., 836; Delaware Breakwater Harbor, Del., 839; Rancocas River, N. J., 841; Woodbury Creek, N. J., 843; Mantua Creek, N. J., 844; Raccoon River, N. J., 844; Salem River, N. J., 846; Cohansey Creek, N. J., 847; removal of wrecks from Delaware Bay and River, 847; removing sunken vessels or craft obstructing or endangering navigation, 848; United States commission advisory to the board of harbor commissioners of Philadelphia, Pa., 849.

APPENDIX G.

REPORT OF MR. WILLIAM F. SMITH, UNITED STATES AGENT.

IMPROVEMENTS.—Maurice River, N. J., 855; Wilmington Harbor, Del., 857; ice-harbor at New Castle, Del., 858; Duck Creek, Del., 859; Saint Jones River, Del., 860; Mispillion Creek, Del., 861; Broadkiln River, Del., 862; Broad Creek, Del., from its mouth to Laurel, 863; Indian River, Del., 864; Susquehanna River above and below Havre de Grace, Md., 864; Chester River at Kent Island Narrows, Md., 866; Chester River from Spray's Landing to Crumpton, Md., 866; Corsica Creek, Md., 867; Choptank River, Md., 868; Wicomico River, Md., 869; Upper Thoroughfare, between Deil's Island and the mainland, Md., 870.

APPENDIX H.

REPORT OF LIEUT. COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Patapsco River and channel to Baltimore, Md., 874; Annapolis Harbor, Md., 877; removing sunken vessels or craft obstructing or endangering navigation, 878.

APPENDIX I.

REPORT OF MAJ. PETER C. HAINS, CORPS OF ENGINEERS, BVT. LIEUT. COL., U. S. A.

Improvements.—Harbors at Washington and Georgetown, D. C., 879; Potomac River at Washington, D. C., 881; James River, Va., 887; Shenandoah River, W. Va., 891.

APPENDIX J.

REPORT OF MR. S. T. ABERT, UNITED STATES AGENT.

Improvements.—Channel at Mount Vernon, Va., 899; Neabsco Creek, Va., 901; Breton Bay, Leonardtown, Md., 901; Nomini Creek, Va., 903; harbor at entrance of Saint Jerome's Creek, Md., 904; Rappahannock River, Va., 906; Totusky River, Va., 913; Urbana Creek, Va., 914; Mattaponi River, Va., 915; Pamunky River, Va., 917; York River, Va., 918; Chickahominy River, Va., 920; Staunton River, Va., 922 and 924; Dan River, between Madison, N. C., and Danville, Va., 925; Roanoke River, N. C. 927; French Broad River, N. C., 929.
Examination.—Aqueduct Bridge over the Potomac at Georgetown, D. C., 931.

APPENDIX K.

REPORT OF CAPT. F. A. HINMAN, CORPS OF ENGINEERS.

Improvements.—Harbor at Norfolk, Va., 951; Approach to Norfolk Harbor and the United States (Norfolk) navy-yard, between Lambert's Point and Fort Norfolk, Va., 956; Appomattox River, Va., 958; Nottoway River, Va., 961; Blackwater River, Va., 961; Archer's Hope River, Va., 962; North Landing River, Va. and N. C., 962; Edenton Bay, N. C., 963; Currituck Sound, Coanjok Bay, and North River Bar, N. C., 965; Meherrin River, N. C., 965; Pamlico and Tar rivers, N. C., 966; Yadkin River, N. C., 967; Scuppernong River, N. C., 969; removing sunken vessels or craft obstructing or endangering navigation, 970.

APPENDIX L.

REPORT OF CAPT. WILLIAM H. BIXBY, CORPS OF ENGINEERS.

Improvements.—Contentnea Creek, N. C., 973; Trent River, N. C., 976; Neuse River, N. C., 979; inland navigation from New Berne to Beaufort Harbor, via Clubfoot, Harlowe, and Newport rivers, N. C., 983; harbor at Beaufort, N. C., 986; New River, N. C., 991; Cape Fear River, above Wilmington, N. C., 995; Cape Fear River, below Wilmington, N. C., 1000; Great Pe Dee River, S. C., 1017; Waccemaw River, S. C., 1022; harbor at Georgetown, S. C., 1027; Santee River, S. C., 1030; Wateree River, S. C., 1053; removing sunken vessels obstructing or endangering navigation, 1060.

APPENDIX M.

REPORT OF COL. Q. A. GILLMORE, CORPS OF ENGINEERS, BVT. MAJ. GEN., U. S. A.

Improvements.—Charleston Harbor, S. C., 1063; Wappoo Cut, S. C., 1077; Ashley River, S. C., 1080; Edisto River, S. C., 1082; Salkiehatchie River, S. C., 1084; Savannah Harbor and River, Ga., 1086; Savannah River, Ga., 1098; Savannah River above Augusta, Ga., 1100; Saint Augustine Creek (Thunderbolt River), Ga., 1102; Romerly Marsh, Ga., 1102; Altamaha River, Ga., 1105; Brunswick Harbor, Ga., 1112; entrance to Cumberland Sound, Ga. and Fla., 1118; inside passage between Fernandina and Saint John's River, Fla., 1124.

APPENDIX N.

REPORT OF LIEUT. WILLIAM M. BLACK, CORPS OF ENGINEERS.

IMPROVEMENTS.—Saint John's River, Fla., 1125; Upper Saint John's River, Fla., 1133; Volusia Bar, Fla., 1135; Tampa Bay, Fla., 1137; Apalachicola Bay, 1140; Suwanee River, Fla., 1143; Key West Harbor, Fla., 1144; Pease Creek, Fla., 1146; harbor at Cedar Keys, Fla., 1148; Manatee River, Fla., 1150; Caloosahatchie River, Fla., 1152; Apalachicola River, Fla., 1153; Withlacoochee River, Fla., 1155; removing sunken vessels or craft obstructing or endangering navigation, 1157.

APPENDIX O.

REPORT OF CAPT. R. L. HOXIE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Ocmulgee River, Ga., 1159; Oconee River, Ga., 1161; Flint River, Ga., 1162; Oostenaula and Coosawattee rivers, Ga., 1165; Coosa River, Ga. and Ala., 1165; Chattahoochee River, Ga. and Ala., 1168; Alabama River, Ala., 1171; Tallapoosa River, Ala., 1172; Cahaba River, Ala., 1173; Conecuh—Escambia River, Fla. and Ala., 1175; Choctawhatchee River, Fla. and Ala., 1176; Bayou La Grange, Fla., 1178; harbor at Pensacola, Fla., 1179.

APPENDIX P.

REPORT OF MAJ. A. N. DAMRELL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mobile Harbor, Ala., 1183; Warrior and Tombigbee rivers, Ala. and Miss., 1193; Tombigbee River, 1196; Black Warrior River, from Tuscaloosa to Daniel's Creek, Ala., 1199; Old Town Creek, Miss., 1200; Noxubee River, Miss., 1201; Pascagoula River, Miss., 1203; harbor at Biloxi Bay, Miss., 1205; Horn Island Pass, Miss., 1206; Pearl River, Miss., below Jackson, 1207; Pearl River, Miss., from Jackson to Carthage, 1212; Pearl River, Miss., between Edinburg and Carthage, 1214.

EXAMINATIONS AND SURVEYS.—Pascagoula River, Miss., from the mills at Moss Point down to the anchorage in the bay, with a view to securing a uniform depth of 12 feet of water, 1215; Wacissa River, Fla., 1220.

APPENDIX Q.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS.

INSPECTION.—Improvement at the South Pass of the Mississippi River, 1225.

APPENDIX R.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Amite River, La., 1239; Tangipahoa River, La., 1241; Tchefuncte River, La., 1242; Tickfaw River, La., 1244; Bayou Teche, La., 1245; connecting Bayou Teche with Grand Lake at Charenton, La., 1259; Bayou Black, La., 1261; Bayou Courtableau, La., 1263; Bayou Terrebonne, La., 1264; Bayou La Fourche, La., 1266; Calcasieu River, La., 1276; Calcasieu Pass., La., 1277; Sabine Pass, Tex., 1278; Sabine River, La. and Tex., 1287; Neches River, Tex., 1288; removing sunken vessels or craft obstructing or endangering navigation, 1290.

APPENDIX S.

REPORT OF MAJ. S. M. MANSFIELD, CORPS OF ENGINEERS, BVT. LIEUT. COL., U. S. A.

IMPROVEMENTS.—Entrance to Galveston Harbor, Tex., 1291; ship-channel in Galveston Bay, Tex., 1322; Trinity River, Tex., 1323; Buffalo Bayou, Tex., 1325; channel over the bar at the mouth of Brazos River, Tex., 1327; Pass Cavado Inlet to Matagorda Bay, Tex., 1328; Aransas Pass and Bay up to Rockport and Corpus Christi, Tex., 1330; harbor at Brazos Santiago, Tex., 1334; protection of river-bank at Fort Brown, Tex., 1336.

APPENDIX T.

REPORT OF CAPT. ERIC BERGLAND, CORPS OF ENGINEERS.

Improvements.—Red River, La. and Ark., 1337; survey of Bayou Pierre, La., 1343; Cypress Bayou, Tex. and La., 1347; Cane River, La., 1349; Loggy Bayou, Lake Bisteneau and the Dorcheat, La., 1350; Ouachita and Black rivers, Ark. and La., 1351; Bayou Bartholomew, La. and Ark., 1353; Bayou Bœuf, La., 1354; Tensas River and Bayou Macon, La., 1355; Bayou D'Arbonne, La., 1356; Yazoo River, Miss., 1357; Big Sunflower River, Miss., 1359; Tchula Lake, Miss., 1360; Tallahatchee River, Miss., 1361; Yallabusha River, Miss., 1362; Steele's Bayou, Miss., 1363; Big Black River, Miss., 1365; Big Hatchee River, Tenn., 1366; South Forked Deer River, Tenn., 1367; water-gauges on the Mississippi River and its principal tributaries, 1368.

APPENDIX U.

REPORT OF CAPT. H. S. TABER, CORPS OF ENGINEERS.

Improvements.—Removing obstructions in Arkansas River, Ark., 1371; Arkansas River at Pine Bluff, Ark., 1375; Black River, Ark. and Mo., 1377; White River, Ark., 1378; White River above Buffalo Shoals, Ark., 1381; Saint Francis River, 1382; Saline River, Ark., 1387; L'Anguille River, Ark., 1388.

Surveys.—Survey of Arkansas River, Ark., from Little Rock to its mouth, 1389; continuation of the survey of Arkansas River from Wichita, Kans., to Fort Gibson, Ind. T., 1391.

APPENDIX V.

REPORT OF MAJ. A. M. MILLER, CORPS OF ENGINEERS.

Improvements.—Removing snags and wrecks from the Mississippi and Missouri rivers, 1393; Osage River, Kans. and Mo., 1395; Gasconade River, Mo., 1396.

APPENDIX W.

REPORT OF CAPT. JAMES B. QUINN, CORPS OF ENGINEERS.

Improvement.—Yellowstone River, Mont. and Dak., 1399.

APPENDIX X.

REPORT OF MAJ. ALEXANDER MACKENZIE, CORPS OF ENGINEERS.

Improvements.—Upper Mississippi River, operations of snag-boats and dredge-boats, 1403; Mississippi River from Saint Paul to Des Moines Rapids, 1412; Mississippi River from Des Moines Rapids to mouth of the Illinois River, 1422; harbor of refuge in Lake Pepin, at Stockholm, Wis., 1422; harbor of refuge in Lake Pepin, at Lake City, Minn., 1424; removal of bar in Mississippi River opposite Dubuque, Iowa, 1424; ice-harbor at Dubuque, Iowa, 1426; Rock Island Rapids, Mississippi River, 1427; Des Moines Rapids, Mississippi River, 1465; operating and care of Des Moines Rapids Canal, 1468; dry-dock at Des Moines Rapids Canal, 1477.

APPENDIX Y.

REPORT OF MAJ. CHARLES J. ALLEN, CORPS OF ENGINEERS.

Improvements.—Preservation of Falls of Saint Anthony, Minn., 1479; Mississippi River above the Falls of Saint Anthony, Minn., 1483; construction of lock and dam on Mississippi River at Meeker's Island, Minn., 1485; Chippewa River, Wis., 1486; Chippewa River at Yellow Banks, Wis., 1488; Saint Croix River below Taylor's Falls, Minn. and Wis., 1490; Minnesota River, Minn., 1494; Red River of the North, Minn. and Dak., 1496; lock and dam at Goose Rapids on Red River of the North, Minn. and Dak., 1500; reservoirs upon the headwaters of the Mississippi River, 1501; surveys for reservoirs at the sources of the Mississippi, Saint Croix, Chippewa, and Wisconsin rivers, 1507.

APPENDIX Z.

REPORT OF LIEUT. COL. J. W. BARLOW, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tennessee River, 1509; Cumberland River, 1515; Hiawassee River, 1519; French Broad River, Tenn., 1520; Clinch River, Tenn., 1521; Duck River, Tenn., 1523; Caney Fork River, Tenn., 1523; Little Tennessee River, Tenn., 1524; South Fork Cumberland River, Ky., 1525.

APPENDIX A A.

REPORT OF LIEUT. COL. WILLIAM E. MERRILL, CORPS OF ENGINEERS, BVT. COL., U. S. A.

IMPROVEMENTS.—Ohio River, 1528; Operating and care of Davis Island Dam, Ohio River, 1540; Monongahela River, W. Va. and Penn., 1542; Operating and care of Lock and Dam No. 9, Monongahela River, 1543; Allegheny River, Pa., 1544; Dam at Herr's Island, Allegheny River, 1545; ice-harbor at mouth of Muskingum River, Ohio, 1546; Muskingum River, Ohio, 1547; operating and care of locks and dams on the Muskingum River, Ohio, 1548; harbor of refuge near Cincinnati, Ohio, 1549; harbor of refuge at mouth of Great Kanawha River, W. Va., 1550.

EXAMINATION AND SURVEY.—Muskingum River, Ohio, 1551.

APPENDIX B B.

REPORT OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Falls of the Ohio River at Louisville, Ky., 1569; Indiana Chute, Falls of the Ohio River, 1572; Louisville and Portland Canal, 1574; Wabash River, Ind. and Ill., 1582; White River, Ind., 1586.

APPENDIX C C.

REPORT OF LIEUT. COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Great Kanawha River, W. Va., 1589; Elk River, W. Va., 1598; New River, from the mouth of Wilson, in Grayson County, Va., to the mouth of Greenbrier River, W. Va., 1599.

APPENDIX D D.

REPORT OF CAPT. JAMES C. POST, CORPS OF ENGINEERS.

IMPROVEMENTS.—Kentucky River, Ky., 1603; operating and keeping in repair locks and dams on the Kentucky River, Ky., 1610; Tradewater River, Ky., 1617; Big Sandy River, W. Va. and Ky., 1618; Guyandotte River, W. Va., 1622; Little Kanawha River, W. Va., 1623; Buckhannon River, W. Va., 1624.

APPENDIX E E.

REPORT OF MAJ. CHARLES J. ALLEN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor at Duluth, Minn., 1627; dredging Superior Bay, Wis., 1632; harbor at Grand Marais, Minn., 1637.

APPENDIX F F.

REPORT OF CAPT. CHARLES E. L. B. DAVIS, CORPS OF ENGINEERS.

Improvements.—Ontonagon Harbor, Mich., 1641; Eagle Harbor, Mich., 1643; Marquette, Harbor, Mich., 1645; harbor of refuge at Grand Marais, Mich., 1646; Manistique Harbor, Mich., 1649; harbor at mouth of Cedar River, Mich., 1650; Menomonee Harbor, Mich. and Wis., 1652; Oconto Harbor, Wis., 1653; Pensaukee Harbor, Wis., 1656; Green Bay Harbor, Wis., 1658; harbor of refuge at entrance of Sturgeon Bay Canal, Wis., 1660; Ahnepee Harbor, Wis., 1662; Kewaunee Harbor, Wis., 1663; Two Rivers Harbor, Wis., 1665; Manitowoc Harbor, Wis., 1667; Sheboygan Harbor, Wis., 1670; Port Washington Harbor, Wis., 1672.
Survey.—Ashland Harbor, in Ashland Bay, Lake Superior, 1674.

APPENDIX G G.

REPORT OF CAPT. W. L. MARSHALL, CORPS OF ENGINEERS.

Improvements.—Harbor of refuge, Milwaukee Bay, Wis., 1679; Milwaukee Harbor, Wis., 1680; Racine Harbor, Wis., 1682; Kenosha Harbor, Wis., 1684; Waukegan Harbor, Ill., 1685; Fox and Wisconsin rivers, Wis., 1686.

APPENDIX H H.

REPORT OF MAJ. W. H. H. BENYAURD, CORPS OF ENGINEERS.

Improvements.—Chicago Harbor, Ill., 1701; Calumet Harbor, Ill., 1704; Illinois River, 1705; Calumet River, 1707.
Surveys.—For Hennepin Canal, 1708.

APPENDIX I I.

REPORT OF CAPT. D. W. LOCKWOOD, CORPS OF ENGINEERS.

Improvements.—Charlevoix Harbor, Mich., 1755; Frankfort Harbor, Mich., 1757; harbor of refuge at Portage Lake, Mich., 1758; Manistee Harbor, Mich., 1759; Ludington Harbor, Mich., 1761; Pentwater Harbor, Mich., 1762; White River Harbor, Mich., 1762; Muskegon Harbor, Mich , 1764; Grand Haven Harbor, Mich., 1766; Grand River, Mich,, 1767; Black Lake Harbor, Mich., 1768; Saugatuck Harbor, Mich., 1769; South Haven Harbor, Mich., 1770; Saint Joseph Harbor, Mich., 1771; Michigan City Harbor, Ind., 1774.

APPENDIX J J.

REPORT OF LIEUT. COL. O. M. POE, CORPS OF ENGINEERS, BVT. BRIG. GEN., U. S. A.

Improvements.—Hay Lake Channel, Saint Mary's River, Mich., 1777; Saint Mary's Falls Canal and River, Mich., 1783; operating and care of Saint Mary's Falls Canal, Mich., 1809; dry-dock at Saint Mary's Falls Canal, Mich., 1823; harbor at Cheboygan, Mich., 1824; harbor at Thunder Bay, Mich., 1825; harbor at Au Sable, Mich., 1825; Saginaw River, Mich., 1826; harbor of refuge, Sand Beach, Lake Huron, Mich., 1829; steam launch or tug for harbor of refuge, Lake Huron, Mich., 1836; ice-harbor of refuge at Belle River, Mich., 1837; general repairs and renewals at Saint Clair Flats Ship Canal, Mich., 1837; operating and care of Saint Clair Flats Canal, Mich., 1838; Clinton River, Mich , 1842; Detroit River, Mich., 1842.

APPENDIX K K.

REPORT OF MAJ. L. COOPER OVERMAN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Monroe Harbor, Mich., 1847; Toledo Harbor, Ohio, 1849; Port Clinton Harbor, Ohio, 1854; Sandusky City Harbor, Ohio, 1855; Sandusky River, Ohio, 1857; Huron Harbor, Ohio, 1858; Vermillion Harbor, Ohio, 1859; mouth of Black River, Ohio, 1861; Rocky River, Ohio, 1862; Cleveland Harbor, Ohio, 1863; Fairport Harbor, Ohio, 1868; Ashtabula Harbor, Ohio, 1871; Conneaut Harbor, Ohio, 1873; Dunkirk Harbor, N. Y., 1874; removing sunken vessels or craft obstructing or endangering navigation, 1876.

APPENDIX L L.

REPORT OF CAPT. EDWARD MAGUIRE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Erie Harbor, Pa., 1879; Buffalo Harbor, N. Y., 1881; Niagara River, N. Y., 1884; Wilson Harbor, N. Y., 1885; Olcott Harbor, N. Y., 1885; Oak Orchard Harbor, N. Y., 1886; Charlotte Harbor, N. Y., 1887; Pultneyville Harbor, N. Y., 1889; Great Sodus Harbor, N. Y., 1890; Little Sodus Harbor, N. Y., 1891; Oswego Harbor, N. Y., 1892; Sackett's Harbor, N. Y., 1894.

APPENDIX M M.

REPORT OF MAJ. M. B. ADAMS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Ogdensburg Harbor, N. Y., 1895; Grass River at Massena, N. Y., 1898; Breakwater at Rouse's Point, Lake Champlain, N. Y., 1899; Swanton Harbor, Vt., 1901; Plattsburg Harbor, N. Y., 1902; Burlington Harbor, Vt., 1903; Otter Creek, Vt., 1905; Ticonderoga River, N. Y., 1905.

APPENDIX N N.

REPORT OF LIEUT. COL. G. H. MENDELL, CORPS OF ENGINEERS, BVT. COL., U. S. A.

IMPROVEMENTS.—Oakland Harbor, Cal., 1907; Wilmington Harbor, Cal., 1911; Redwood Harbor, Cal., 1914; removal of sunken vessels or craft obstructing or endangering navigation, 1915.

APPENDIX O O.

REPORT OF COL. C. SEAFORTH STEWART, CORPS OF ENGINEERS.

IMPROVEMENT.—Harbor at San Diego, Cal., 1917.

APPENDIX P P.

REPORT OF CAPT. A. H. PAYSON, CORPS OF ENGINEERS.

IMPROVEMENTS.—Humboldt Harbor and Bay, Cal., 1919; San Joaquin River, Stockton and Mormon sloughs, Cal., 1921; Mokelumne River, Cal., 1924; Sacramento and Feather rivers, Cal., 1926; Colorado River, Nev., Cal., and Ariz., 1929.

APPENDIX Q Q.

REPORT OF MAJ. W. A. JONES, CORPS OF ENGINEERS.

IMPROVEMENTS.—Columbia and Willamette rivers below Portland, Oreg., 1938; Upper Willamette River, Oreg., 1940; Columbia River at Cascades, Oreg., 1942; Upper Columbia and Snake rivers, Oreg. and Wash., 1949; Cowlitz River, Wash. 1952; Lower Clearwater River, Idaho, 1952.

EXAMINATIONS AND SURVEYS.—Columbia River above mouth of Snake River, Wash., 1953; Columbia and Snake rivers, 1970.

APPENDIX R R.

REPORT OF CAPT. CHARLES F. POWELL, CORPS OF ENGINEERS.

Improvements.—Mouth of the Columbia River, Oreg. and Wash., 1972; entrance to Coos Bay, Oreg., 1989; entrance to Yaquina Bay, Oreg., 1998; mouth of Coquille River, Oreg., 2003; Umpqua River, Oreg., 2005; Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie rivers, Wash., 2007; Chehalis River, Wash., 2009; gauging waters of the Columbia River and principal tributaries, 2010.

APPENDIX S S.

REPORT OF MAJ. G. J. LYDECKER, CORPS OF ENGINEERS.

Improvements.—Washington Aqueduct, 2013; increasing the water supply of the city of Washington, 2043; erection of fish-ways at the Great Falls of the Potomac River, 2061.

APPENDIX T T.

REPORT OF COL. JOHN M. WILSON, U. S. A.

Improvement and care of public buildings and grounds in the District of Columbia, 2075.

APPENDIX U U.

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

Bridge across the Mississippi River at Keithsburg, in the State of Illinois, 2111; stone-arch bridge across the West Channel of the Mississippi River at Minneapolis, Minn., 2111; proposed bridge across the Ohio River at or near Cairo, Ill., 2116; bridge of the Selma Bridge Company across the Alabama River at Selma, Ala., 2136; changes in the original plan of the bridge across the Ohio River at Henderson Ky., 2137.

APPENDIX V V.

SUPPLEMENTAL REPORT OF THE MISSISSIPPI RIVER COMMISSION, 2143.

Q. A. Gillmore, Col. of Engineers, Bvt. Maj. Gen., U. S. A., *President.*
C. B. Comstock, Lieut. Col. of Engineers, Bvt. Brig. Gen., U. S. A.,
Charles R. Suter, Major of Engineers, U. S. A.,
Mr. Henry Mitchell, Coast and Geodetic Survey,
Mr. B. M. Harrod, Civil Engineer,
Mr. S. W. Ferguson, Civil Engineer,
Mr. Robert S. Taylor,
Commissioners.

APPENDIX W W.

SUPPLEMENTARY REPORT OF THE MISSOURI RIVER COMMISSION, 2167.

Charles R. Suter, Major of Engineers, U. S. A., *President.*
Alex. Mackenzie, Major of Engineers,
O. H. Ernst, Major of Engineers,
Mr. G. C. Broadhead,
Mr. William J. Broatch,
Commissioners.

APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

APPENDIX F.

IMPROVEMENT OF DELAWARE AND SCHUYLKILL RIVERS, AND OF RIVERS IN NEW JERSEY—HARBOR IMPROVEMENTS IN DELAWARE RIVER AND BAY—CONSTRUCTION OF PIER AT LEWES—DELAWARE BREAKWATER.

REPORT OF LIEUTENANT-COLONEL HENRY M. ROBERT, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Delaware River from Trenton, New Jersey, to its mouth.
2. Delaware River at Schooner Ledge.
3. Delaware River near Cherry Island Flats.
4. Frankford Creek, Pennsylvania.
5. Schuylkill River, Pennsylvania.
6. Ice-Harbor at Marcus Hook, Pennsylvania.
7. Ice-Harbor at the head of Delaware Bay, Delaware.
8. Construction of iron pier in Delaware Bay, near Lewes, Del.
9. Delaware Breakwater Harbor, Delaware.
10. Rancocas River, New Jersey.
11. Woodbury Creek, New Jersey.
12. Mantua Creek, New Jersey.
13. Raccoon River, New Jersey.
14. Salem River, New Jersey.
15. Cohansey Creek, New Jersey.
16. Removal of wrecks from Delaware Bay and River.
17. Removing sunken vessels or craft obstructing or endangering navigation.
18. United States commission advisory to the board of harbor commissioners of Philadelphia, Pennsylvania.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., July 29, 1886.

SIR: I have the honor to transmit herewith annual reports for the fiscal year ending June 30, 1886, of the river and harbor works under my charge.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

F 1.

IMPROVEMENT OF DELAWARE RIVER FROM TRENTON, NEW JERSEY, TO ITS MOUTH.

The river and harbor act of July 5, 1884, contained an appropriation of $200,000 for improving Delaware River from Trenton, N. J., to its mouth, "provided that not exceeding $10,000 of said sum shall be expended above Bridesburg."

A project was submitted January 23, 1885, by a Board of Engineers for "the permanent improvement of Delaware River and Bay," which was published in the Report of the Chief of Engineers for 1885, page 822. The expenditure of the appropriation of July 5, 1884, has been in accordance with approved projects and the recommendations of this Board.

During the past fiscal year the following operations have been in progress:

(1) Survey of the Delaware River above Bridesburg.

(2) Examinations at points between the upper end of Petty's Island and Delaware Bay, where there is now a less depth than 26 feet at mean low water and a less width of channel than 600 feet, to determine the character of the bottom and substratum of the river both in channels to be improved and over areas to be occupied by proposed dikes; tidal observations at the same points, to determine the duration, direction, and velocity of the flood and ebb tides; and the running of a line of levels between Trenton, N. J., and Cape Henlopen, Delaware.

(3) Construction of a gravel dike between Long Bar and Emily Island in the river above Bordentown.

(4) Construction of a brush and stone dike near Five-Mile Bar, between Fisher's Point and upper end of Petty's Island.

(5) Construction of a brush and stone dike near Mifflin Bar, between Hog and Maiden islands.

(6) Dredging a channel through Five-Mile Bar above Petty's Island.

(7) Dredging in Main Ship-Channel west of Petty's Island.

(8) Dredging in Main Ship-Channel at Mifflin Bar.

The other matters relating to the improvement of the Delaware River will be considered under the following heads:

(9) Smith's Island Bar.

(10) Injunction restraining contractors from building Fisher's Point Dike.

1. SURVEY OF THE DELAWARE RIVER ABOVE BRIDESBURG.

The survey of the Delaware River above Bridesburg consisted in a detailed survey, which was carried to a point about 4 miles below Trenton, or for a distance of about 24 miles above Bridesburg. The exhaustion of available funds prevented the completion of the survey.

2. EXAMINATIONS, TIDAL OBSERVATIONS, AND LEVELS BELOW BRIDESBURG.

The examinations and tidal observations at special points requiring improvement between Philadelphia and the Bay consisted in borings and probings, to determine the character of the bottom of the river both in the channels to be improved and over the sites of proposed dikes; and in tidal observations, to determine the duration, direction, and velocity of tidal currents. The determination of the character of the river bed and substratum was made by borings carried to a depth of from 30 to 40 feet below mean low water in the channels to be improved, and to varying depths over the areas to be occupied by the proposed dikes. Samples of the material passed through by the boring-rod were obtained, and are preserved for future reference.

Observations to determine the height and duration of the tides were made by self-registering tide-gauges placed in the vicinity of required improvements. The direction of tidal currents was obtained by immersed floats. Meters connected with recording chronographs were used to determine the velocity of the currents at the various stages of the tides.

The localities at which these examinations and tidal observations were made are the following: Fisher's Point or Five-Mile Bar, Mifflin Bar, Marcus Hook, Holly Oak, Salem Cove, Dan Baker Shoals, and Dutch Creek Flats. The funds available for this work were not sufficient to carry it to the degree of completion desired, and the work should be continued under future appropriations. The results already obtained will be a valuable aid in locating such works of improvement as it may be possible to undertake in the near future.

3. DIKE BETWEEN LONG BAR AND EMILY ISLANDS.

In the upper river, at a point about 2 miles below Trenton, a gravel dike was built across the inlet between Long Bar and Emily Islands, to replace the timber and stone dike built some years ago and subsequently destroyed by freshets. (Emily Island is now practically a part of the mainland.) The dike built during the past fiscal year was constructed of coarse material dredged from the vicinity of Periwig Shoal and transported to the site of the work on flat scows. The dike was about 300 feet long, 75 feet wide at base, and 30 feet wide at top, and was raised to a height of about 1 foot above ordinary high water. The work was done during the months of August and September, under an agreement with Frank C. Somers, at the rate of 59½ cents per cubic yard for material placed in the work. The cost of the dike was $2,062.09. During the spring freshets the height of the dike was somewhat reduced by the flow of water over its crest. The principal value of the work is that it affords a means of crossing for teams between the islands under cultivation and the adjacent mainland, and it was undertaken because in the construction of the previously built dike a channel had been dredged from the river into the inlet between the islands, which destroyed a then-existing road across the inlet.

4. DIKE BETWEEN FISHER'S POINT AND PETTY'S ISLAND.

Under a contract with John A. Bouker, dated August 7, 1885, a brush and stone dike was built, extending for a distance of 3,500 feet from the mainland at Fisher's Point towards the upper end of Petty's Island. The upper 3,000 linear feet of dike were brought to the height of mean low water, and the remaining 500 linear feet were extended as a sill, the top of which was about 10 feet below mean low water, to guard against possible scour at the lower end of the work. The dike consisted of a foundation or sill of brush mattresses 2½ feet thick and from 25 to 30 feet wide, surmounted with an embankment of random stone carried to the heights above named.

In this work 2,116 linear feet of piles, 7,031 cubic yards of mattress, and 14,878 cubic yards of stone were used. The brush mattress foundation or sill was placed upon an embankment about 100 feet wide and raised to a height of about 10 feet below mean low water, consisting of the dredged material removed from the main ship-channel west of Petty's Island and placed in the embankment under the hereafter-described contract with the American Dredging Company. This material, consisting of gravel and bowlders, was of a character to resist scour, and consequently could be used with safety as a substructure for the dike. Its use permitted the construction of the dike with such reduced quantities of brush mattress and stone as to result in a saving of about $10,000 in the cost of the dike, without any increased cost to the dredging.

The work provided for under this contract was to have been completed by December 15, 1885, but the progress of the work was entirely suspended between September 4 and October 17, by the injunction of the State of New Jersey, issued against all parties engaged in the construction of the dike. On account of this delay an extension of the time originally named for the completion of the contract was granted to June 30, 1886. (For an account of the injunction and other hindrances, see No. 10.)

5. DIKE BETWEEN HOG AND MAIDEN ISLANDS (MIFFLIN BAR).

Under date of July 30, 1885, a contract was entered into with Elijah D. Register for the construction of about 5,500 linear feet of brush and stone dike between Hog and Maiden Islands, near Mifflin Bar. At the date for the completion of the contract, December 15, 1885, about one-fourth of the contract had been completed. The contractor for this work had been erroneously included among the parties enjoined from prosecuting the construction of Fisher's Point Dike, and although the injunction issued did not apply to his contract, the work was delayed from an apprehension that if the injunction upon the Fisher's Point Dike was maintained by the courts it would be followed by an injunction against the dike covered by his contract. At the close of the season's work about 1,960 linear feet of dike had been built, covering about 35 per cent. of the work to be done under the contract. Although the progress of the work had not been satisfactory, an extension of time to June 30, 1886, was granted, provided that at the beginning of the present season work was resumed with proper energy. After continued delay to recommence the work, the contract was finally annulled April 20, 1886, with a forfeiture to the United States of $2,944.87 of retained moneys.

The work remaining to be done under the contract with Elijah D. Register was readvertised, and on May 31, 1886, a contract was entered into with the lowest bidders, Robert Patterson & Son, for the construction of about 3,500 linear feet of dike. At the close of the fiscal year, 870 linear feet of dike had been partially built under this contract.

The loss to the United States by this failure consists in the increased amount of dredging on Mifflin Bar, due to the delay in building the dike, which was designed to maintain the channel dredged across the bar last summer. The increased price for work under the new contract, as well as the increased cost of inspection, will be covered by the retained moneys forfeited to the United States.

Under date of April 26, 1886, a contract was made with John A. Bonker for the construction of about 1,800 linear feet of brush and stone dike in prolongation of the dike to be built under contract with Elijah D. Register, just referred to. At the close of the fiscal year the sill or foundation of the work, 1,800 feet long and 25 feet wide, had been placed, covering 1,746 cubic yards of brush mattress, and 3,587 cubic yards of stone deposited thereon.

The brush mattresses built this season differ from those used under the contracts of last season, in that they are composed of loose brush in place of fascines, secured between binding frames, and with a depth of 1 foot of brush in place of 2 and 2½ feet, as before.

6. DREDGING AT FIVE-MILE BAR.

Under date of April 9, 1886, proposals were invited for about 100,000 cubic yards of dredging for the formation of a channel through Five-

Mile Bar, just above the upper end of Petty's Island. The bids received, varying from $17\frac{8}{10}$ to 26 cents per cubic yard (the former bid being limited, however, to 50,000 cubic yards), were considered too high, and being slightly informal were therefore rejected and proposals by circular letter invited from the previous bidders for the removal of about 50,000 cubic yards. In response, the lowest bid was that of the American Dredging Company, at the rate of 9 cents per cubic yard, which was accepted. The dredging was commenced May 14, 1886, and early in June the 50,000 cubic yards of material were removed, and the results obtained seemed to justify a continuation of the dredging to the aggregate amount of 125,000 cubic yards.

By the authority of the Secretary of War the work was continued under an agreement with the American Dredging Company for the removal of the additional 75,000 cubic yards at the same rate as for the previous work. At the close of the fiscal year 91,194 cubic yards had been removed, and the entire amount will be removed before July 20.

The material, consisting of fine sand, was deposited by the scows immediately against the rear slope of the dike, thereby adding to its stability against the ice pressure of winter freshets.

The depth originally over the bar at mean low water was from 3 to 6 feet, and the distance across the bar, between the 12-foot curves, about 1,800 feet. The location of the dredged channel is near to the Philadelphia shore and in such a direction as to be coincident with the paths of both flood and ebb tides across the bar, as determined from recent tidal observations.

The object of the dredging in progress is the formation of a channel 12 feet deep at mean low water, connecting the deep water above with the deep water below the bar; this will afford great relief to the commerce moving between Philadelphia and the river above. This channel is not supposed to be permanent, but its value is so great as to be worth some cost in maintaining it.

7. DREDGING IN THE MAIN SHIP-CHANNEL WEST OF PETTY'S ISLAND.

Under a contract with the American Dredging Company dated July 29, 1885, for dredging in the main ship-channel west of Petty's Island, and under an agreement with the same company, dated November 18, 1885, for a continuation of the work at the same locality, 105,331 cubic yards of material were removed. The excavation was carried to a depth of 26 feet at mean low water, and resulted in increasing the previous channel to a width of about 400 feet.

The material excavated consisted of gravel and bowlders, the removal of which was estimated by the Board of Engineers in 1885 at 50 cents per cubic yard, the estimate being based upon previous prices at this locality. The work done under the above-named contract and agreement was at the rate of $19\frac{1}{2}$ cents per cubic yard. The character of the material was such as to permit its deposition in the form of a wide embankment under the sill of the dike between Fisher's Point and Petty's Island, reducing the depth of water on the line of the dike to about 10 feet, and permitting the construction of the dike by such a reduced quantity of brush mattress and stone as to result in a saving of about $10,000 in the cost of the dike.

On September 4, 1885, the State of New Jersey served an injunction upon the American Dredging Company, enjoining them from the further placing of dredged material in the foundation of the dike then in process of construction by the United States between Fisher's Point and Petty's

Island. The injunction was dissolved by the United States circuit court on October 17, 1885, and the construction of the foundation of the dike by the use of dredged material resumed and continued to the close of the agreement with the American Dredging Company.' During the interval between September 4 and October 17, 1885, the material (about 27,000 cubic yards) dredged under the contract was deposited behind the dike in process of construction, near Mifflin Bar. Further allusions to this injunction are made in a subsequent part of this report.

The increased width to the main ship-channel, which resulted from the dredging done under this contract, has made the piers at Port Richmond available for the deep draught ocean steamers, and has been a valuable aid in the development of the large commercial interests belonging to this part of the river front.

8. DREDGING AT MIFFLIN BAR.

Under a contract with the American Dredging Company, dated July 29, 1885, 98,145 cubic yards of material were removed from the channel across Mifflin Bar, at the rate of 9½ cents per cubic yard. The dredged material was deposited by scows in the area behind the dike between Hog and Maiden islands, in process of construction, for the improvement of the channel at Mifflin Bar. The dredging was carried to a depth of 26 feet at mean low water, and resulted in deepening the channel for a width of about 125 feet.

9. SMITH'S ISLAND BAR.

The cross-river traffic between Philadelphia and Camden is obstructed by Windmill and Smith's islands and by Smith's Island Bar. The islands and bar form a continuous obstruction nearly 1½ miles in length, except at a narrow passage between Windmill and Smith's islands, which was opened and is maintained by private enterprise.

There can be no question as to the necessity for an improved channel which will afford direct and convenient connection between the deep water in front of the two cities, and to the large inter-State commerce affected thereby.

The appended report considers the plan for the formation of a channel 200 feet wide and 10 feet deep at mean low water at a point directly above the upper end of Smith's Island, and at the lower end of the bar. The general direction of the bar is such as to place any channel through the bar more or less across the line of tidal flow. To provide, as far as possible, against the liability of such a channel refilling, its axis is proposed to be placed quite oblique to the line of the bar, and its sides protected by a revetment. The estimated cost of the work is $40,000, of which $20,000 is for dredging and the remainder for the construction of the revetment.

If an appropriation is made for this work it should be specified for the improvement of channel between Philadelphia, Pa., and Camden, N. J., as it is no part of the present project for the improvement of the main ship-channel of the Delaware River.

10. INJUNCTION AGAINST BUILDING FISHER'S POINT DIKE.

The construction of the dike at Fisher's Point, which was recommended by the Board of Engineers of 1884, for the improvement of the river near Petty's Island, met with such opposition from the interests of Camden, N. J., as to necessitate an adjudication by the courts of the question of the right of the United States to continue its construction.

The Board of Engineers considered that the recommended improvement for this part of the river—

> Could be procured by building a deflecting dike, starting from Fisher's Point and running down-stream in a slightly curved direction, sensibly parallel with the pier-line of the Pennsylvania shore opposite, extending toward the head of Petty's Island as far as might be necessary for the purpose of diverting into the west channel a considerable part of the ebb tidal volume now passing down the east channel.
>
> When this dike shall have been extended sufficiently far to produce the necessary scour in the west channel, it should stop. It is probable, however, that in the construction of this dike an injurious scour may occur at and beyond its outer end as it progresses, and to prevent this it is recommended that a mattress sill of brush not more than 3 feet in thickness be kept well in advance of the outer end of the dike, and it may be necessary to extend this sill as far as the head of the island. Should any tendency to scouring be noticed at the head of the island, then that part should be protected by a revetment.
>
> The works designed for this locality will leave the channels on both sides of the island open, and will probably benefit that on the west side without doing injury to that on the east side.

The construction of this dike was commenced by the United States early in August, 1885, under contracts with the American Dredging Company for the depositing of dredged material in the foundation of the dike, and with John A. Bouker for the construction and placing of the brush mattresses and stone forming the body of the work.

On September 4, 1885, both contractors were enjoined by the State of New Jersey from further work upon the dike. A copy of the information upon which the injunction was granted is appended as Schedule A and the injunction as Schedule B. In accordance with the requirements of the injunction, operations upon the dike at once ceased.

By instructions from the Department of Justice, United States District Attorney Hon. John K. Valentine, at Philadelphia, was directed to take such steps as might be necessary to protect the interests of the United States in connection with the injunction against the Government contractors restraining them from building the dike in question.

The proceedings were commenced in the court of chancery for the State of New Jersey, but were removed into the circuit court of the United States for the district of New Jersey. In the September term of court the American Dredging Company and John A. Bouker, defendants, submitted their answer to the bill of complaint of the attorney-general of the State of New Jersey, informant, as shown in Schedule C.

On October 17 the case was heard under the argument of United States District Attorney John K. Valentine, as set forth in Schedule D, and on the same date the injunction was dissolved by the court.

Under date of September 30 Hon. W. J. Sewell, United States Senator, submitted to the honorable the Secretary of War a statement of the injuries to public and private rights which would result from the construction of the proposed work, with a request that before operations were resumed upon the dike the Board of Engineers be reconvened to take into consideration the objections urged. This communication was referred to the officer in charge for report, and will be found with the report appended as Schedule E.

By Special Orders No. 167, Headquarters Corps of Engineers, United States Army, Washington, D. C., October 22, 1885, the Board of Engineers of 1884 was reconvened at Philadelphia for the purpose of considering certain objections made by citizens of Camden to the construction of the dike in question. The Board met on October 26, 1885, and under date of October 28, submitted to the Chief of Engineers their report. This report, together with the recommendations of the Chief of Engineers, and the approval of the same by the honorable the Secretary of War, is appended as Schedule F.

During the present season available funds will be applied to the work in progress towards the formation of a dredged channel 12 feet deep at mean low water through Five-Mile Bar, above Petty's Island, and to the work of dike construction near Mifflin Bar.

In the reports on special localities on the Delaware River where separate appropriations have been made in the past, it has been recommended that, in the best interests of the work and of commerce, all funds for the improvement of the channel of the Delaware River should be hereafter appropriated under the general title of "improvement of Delaware River from Trenton, N. J., to its mouth." The improvement recommended by the Board of 1884 is the formation of a channel from a point in the river near the upper part of Philadelphia to deep water in Delaware Bay, with a least width of 600 feet, and having a depth of 26 feet at mean low water. This is to be accomplished, except at Schooner Ledge, where solid rock is to be removed, by means of regulating and constructing works, aided, where necessary, by dredging. The estimated cost of the work recommended is about $2,425,000.

An appropriation of $600,000 is recommended for the fiscal year ending June 30, 1888, to be applied to dredging and dike construction, together with any necessary surveys and observations, all in accordance with the project for the permanent improvement of Delaware River and Bay.

The Delaware River is tributary to the following collection districts, Trenton, Philadelphia, Delaware, and Bridgeton. The amount of revenue collected in these districts during the year ending December 31, 1885, was $13,812,764.54. Total amount appropriated for improvement of Delaware River from 1836 to June 30, 1886, $1,552,000.

Total expeditnres to June 30, 1886	$1,499,717 92
Total amount appropriated on present project to June 30, 1886	200,000 00
Total expenditures on present project to June 30, 1886	147,717 92

Money statement.

July 1, 1885, amount available		$185,555 96
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$133,273 88	
July 1, 1886, outstanding liabilities	34,374 09	
		167,647 97
July 1, 1886, amount available		17,907 99
Amount appropriated by act approved August 5, 1886		210,000 00
Amount available for fiscal year ending June 30, 1887		227,907 99

Amount (estimated) required for completion of existing project	*2,215,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	600,000 00
Submitted to compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

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*The estimated cost of the permanent improvement of the Delaware River between the upper part of Philadelphia and deep water in the bay was $2,425,123. The entire cost of the permanent improvement of the river between Trenton, N. J., and its mouth cannot be stated until after the completion of the survey now in progress between Bridesburg and Trenton, and the formation of a project based thereon.

Abstract of proposals for dredging in Delaware River, west of Petty's Island, received and opened July 20, 1885, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Price per cubic yard.	Remarks.
1	Frank C. Somers, Philadelphia, Pa	$0 27	
2	New York Steam Dredging Company, New York City	0 75	Bowlders of 1 ton or over, at $6 per ton.
3	American Dredging Company, Philadelphia, Pa	0 19½	Recommended for acceptance.

Contract (dated July 29, 1885) awarded to American Dredging Company.

Abstracts of proposals for dredging in Delaware River at Mifflin Bar, received and opened July 20, 1885, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Price per cubic yard.	Remarks.
1	New York Steam Dredging Company, New York City	$0 26	
2	National Dredging Company, Wilmington, Del	0 14	
3	American Dredging Company, Philadelphia, Pa	0 09½	Recommended for acceptance.

Contract (dated July 29, 1885) awarded to American Dredging Company.

Abstract of proposals for constructing a dike in Delaware River between Hog and Maiden islands, received and opened July 23, 1885, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Approximate quantities.				Total.
		Piles, 4,000 linear feet.	Brush mattress, 10,500 cubic yards.	Annealed iron wire, 33,000 pounds.	Stone, 13,000 cubic yards.	
		Per lin. ft.	*Per cu. yd.*	*Per lb.*	*Per cu. yd.*	
1	John Satterlee, Englewood, N. J	$0 30	$1 50	$0 05	$2 40	$49,800 00
2	Frank Pidgeon, New York City	30	5 98	08	1 97	90,590 00
3	Joseph S. Allen and John P. Eyre, Philadelphia, Pa	14	2 31	09½	1 94	53,170 00
*4	Elijah D. Register, Lewes, Del	13	1 69	02½	1 17	34,300 00
5	John F. Dawson, New York City	09½	1 65	03¾	1 79	42,212 50
6	Michael Herron, Bordentown, N. J Michael O'Rourke, Philadelphia, Pa	17	4 50	03¾	2 37	79,977 50
7	Neveling & Co., Philadelphia, Pa	15	2 00	03	1 60	43,390 00
8	John A. Bouker, New York City	20	1 87	05	1 75	44,835 00
9	American Dredging Co., Philadelphia, Pa.	14	2 73	03	1 95	55,565 00
10	Samuel R. Cumming, New York City	25	1 92	08	1 65	45,250 00

*Recommended for acceptance.

Contract (dated July 30, 1885) awarded to Elijah D. Register. Contract annulled April 20, 1886.

INFORMALITIES IN PROPOSALS.

No. 1. Notarial seal omitted from justification of one guarantor.
2. Certificate signed by notary public instead of United States official.
3. Only one guarantor; no certificate.
5. Certificate signed by notary public instead of United States official, and of the three signatures of the notary only one has the title.
6. Signatures of guarantors without seals, and price in figures omitted.
7. Signatures of guarantors without seals, the two bids differ in price of stone, and one guarantor's signature omitted from one bid.
8. In one copy of bid price of brush as given in figures differs from the price in words.
10. Certificate signed by both a notary public and the chief clerk navy pay office instead of by United States official.

Abstract of proposals for constructing a dike in Delaware River between Fisher's Point and Petty's Island, received and opened July 23, 1885, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Approximate quantities.				Total.
		Piles, 2,000 linear feet.	Brush mattress, 8,800 cubic yards.	Annealed iron wire, 22,000 pounds.	Stone, 14,000 cubic yards.	
		Per lin. ft.	*Per cu. yd.*	*Per lb.*	*Per cu. yd.*	
1	Frank Pidgeon, New York City	$0 30	$5 98	$0 03	$1 97	$81, 464
2	J. P. Eyre & Co., Philadelphia, Pa	14	2 31	09½	1 85	48, 598
3	Michael Herron, Bordentown, N. J Michael O'Rourke, Philadelphia, Pa	17	4 50	03¾	2 37	73, 945
4	Neveling & Co., Philadelphia, Pa	03	2 00	03	1 60	40, 720
5	John A. Bouker, New York City	20	1 83	05	1 70	41, 404
6	American Dredging Co., Philadelphia, Pa	14	2 73	03	1 95	52, 264
7	Samuel R. Cumming, New York City	25	1 92	08	1 65	42, 256
8	John Satterlee, Englewood, N. J	20	1 50	05	2 40	48, 300
9	John F. Dawson, New York City	09½	1 65	03¾	1 79	40, 595

Contract (dated August 7, 1885) awarded to John A. Bouker.

INFORMALTIES IN PROPOSALS.

No. 1. Certificate signed by a notary public instead of United States official.
3. No seals attached to signatures of guarantors, and prices in figures omitted.
4. No seals attached to signatures of guarantors, and the two copies of bid differ in prices of piles and stone, the copy giving the lowest prices being entered in abstract.
7. Certificate signed by notary public and by chief clerk navy pay office instead of United States official.
8. Signature of one guarantor unwitnessed, and notarial seal omitted with signature of notary to one justification.
9. Certificate signed by notary public instead of United States official, and title omitted from two of his three signatures.

Abstract of proposals for furnishing and delivering 20 tons coal at United States Engineer Office, No. 1125 Girard street, Philadelphia, Pa., received in response to circular letter, and opened October 28, 1885, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Fourteen tons broken coal.	Six tons stove coal.	Amount.
		Per ton.	*Per ton.*	
1	O'Brien & Co., Philadelphia, Pa	$5 50	$5 75	$111 50
2	Frank K. Ward, Philadelphia, Pa	5 20	5 24	104 24
3	Branson & Bro., Philadelphia, Pa	4 80	4 98	*97 08
4	Wm. Jordan, Philadelphia, Pa	5 15	5 35	104 20

* Accepted.

Abstract of proposals for constructing a dike in Delaware River between Hog and Maiden islands, received and opened April 22, 1886, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Approximate quantities.				Total.
		Piles, 1,000 linear feet.	Brush mattress, 1,800 cubic yards.	Annealed iron wire, 3,000 pounds.	Stone, 12,000 cubic yards.	
		Per lin. ft.	*Per cu. yd.*	*Per lb.*	*Per cu. yd.*	
1	William M. Field, Kentmere, Del.	$0 17	$1 75	$0 03	$1 50	$21,410
2	United States Dredging and Canal Construction Company, New York City	20	1 68	07	1 75	24,484
*3	B. G. Bailey, New York City	35	4 00	15	2 70	40,400
4	Ira Lunt, New Castle, Del.	20	1 75	05	1 50	21,500
*5	H. S. Wright, Philadelphia, Pa	20	1 85	05	1 74	24,560
6	Robert Patterson & Son, Philadelphia, Pa	14	1 68	03	1 58	22,214
7	John Satterlee, Englewood, N. J	19	1 05	03	1 61	21,490
†8	John A. Bouker, New York City	20	1 70	05	1 45	20,810
9	Waldo Danforth, Bergen Point, N.J.	15	2 10	05	1 84	26,160

* Informal. † Recommended for acceptance.

Contract (dated April 26, 1886) awarded to John A. Bouker. In progress.

Abstract of proposals for dredging in the Delaware River, at Five-Mile Bar above Petty's Island, received and opened April 29, 1886, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Price per cubic yard for—		
		First 50,000 cubic yards.	Quantity in excess of 50,000 cubic yards.	Total quantity that may be required.
		Cents.	*Cents.*	*Cents.*
1	Edgar M. Payn, Albany, N. Y	17.9		
2	Frank C. Somers, Philadelphia, Pa			28½
3	The Delaware and Chesapeake Improvement Company, Philadelphia, Pa			26
4	American Dredging Company, Philadelphia, Pa	20	19	

INFORMALITIES IN PROPOSALS.

No. 1. Bid limited to 50,000 cubic yards: failed to comply with paragraph 16 of instructions to bidders, bid being sent by mail in a single envelope with nothing to indicate its contents.
No. 2. No seals attached to signatures of guarantors.
No. 3. Certificate of justification signed by a notary public instead of United States official.
No. 4. Notarial seal omitted to justifictaion of one guarantor.

All bids rejected.

Abstract of proposals for furnishing and delivering stationery at the United States Engineer Office, No. 1125 Girard street, Philadelphia, Pa., received in response to circular-letter and opened May 18, 1886, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Amount.
1	Joe H. Mann, Philadelphia, Pa	$117 16
*2	Altemus & Co., Philadelphia, Pa	119 08
†3	C. A. Smith, Philadelphia, Pa	115 40

*This bid omits the last two items bid for by the other two parties at $3 and $3.12, respectively.
†Accepted.

Abstract of proposals for constructing a dike in Delaware River between Hog and Maiden islands, received and opened May 20, 1886, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Approximate quantities.				Total.
		Piles, 2,500 linear feet.	Brush mattress, 3,600 cubic yards.	Annealed iron wire, 5,500 pounds.	Stone, 10,000 cubic yards.	
		Per lin. ft.	*Per cu. yd.*	*Per lb.*	*Per cu. yd.*	
1	John Satterlee, Englewood, N. J	$0 19	$1 69	$0 04	$1 49	$21,679 00
*2	Robert Patterson & Son, Philadelphia, Pa	14	1 53	03	1 38½	19,873 00
3	William M. Field, Wilmington, Del.	16	1 65	02½	1 39	20,377 50
4	Ira Lunt, New Castle, Del	18	1 67½	05	1 44	21,155 00
5	John A. Bouker, New York, N. Y	20	1 53	05	1 45	20,783 00

* Recommended for acceptance.

Contract (dated May 31, 1886) awarded to Robert Patterson & Son. In progress.

Abstract of proposals for furnishing and delivering coal, as may be required, during the season of 1886, for use of the United States steam-yacht Mermaid and launch Portia, received in response to circular-letter and opened June 22, 1886, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Price per ton.	Remarks.
1	George B. Newton & Co., Philadelphia, Pa	$4 25	
2	William F. Moody & Son, Philadelphia, Pa	3 95	Accepted.

Abstract of formal written contracts for improvements in the Delaware River entered into during the fiscal year ending June 30, 1886.

Date of contract.	Names and addresses of contractors.	Subject of contract.	Prices.				
			Dredging per cubic yard.	Dike construction.			
				Piles, per linear foot.	Brush mattress, per cubic yard.	Annealed iron wire, per pound.	Stone, per cubic yard.
			Cents.	*Cents.*	*Dollars.*	*Cents.*	*Dollars.*
[1] July 29, 1885	American Dredging Co., Philadelphia, Pa.	Dredging west of Petty's Island.	19½	....	....	......	....
[2] July 29, 1885	American Dredging Co., Philadelphia, Pa.	Dredging at Mifflin Bar.	9½	......	....	.....	....
[3] July 30, 1885	Elijah D. Register, Lewes, Del.	Dike between Hog and Maiden islands.	....	13	1 69	2½	1 17
[4] Aug. 7, 1885	John A. Bouker, New York City.	Dike between Fisher's Point and Petty's Island.	....	20	1 83	5	1 70
April 26, 1886	John A. Bouker, New York City.	Dike between Hog and Maiden islands[5]	....	20	1 70	5	1 45
May 31, 1886	Robert Patterson & Son, Philadelphia, Pa	Dike between Hog and Maiden islands[5]	....	14	1 53	3	1 38½

[1] Completed November 17, 1885.
[2] Completed October 14, 1885.
[3] Annulled April 20, 1886.
[4] Completed June 30, 1886.
[5] In progress.

PAPERS RELATING TO THE ACTION OF THE STATE OF NEW JERSEY AGAINST THE CONTRACTORS FOR BUILDING THE FISHER'S POINT DIKE, REFERRED TO IN THE PREVIOUS PART OF THIS REPORT.

SCHEDULE A.—THE INFORMATION.

In Chancery of New Jersey.

To his honor THEODORE RUNYON,
Chancellor of the State of New Jersey:

Humbly informing your informant, John P. Stockton, attorney-general of the State of New Jersey, who informs for and on behalf of said State, informs and shows unto your honor as follows:

I. That the ground and soil of the coast and shores of the sea around the territory of the State of New Jersey, and of every port, haven, and arm of the sea, creek, pool, and navigable river which are wholly within the boundaries of said State, and into which the sea ebbs and flows, and also the ground and soil of all that part of the Delaware and Hudson rivers, and of New York Bay or harbor, and of the Kill von Kull, Staten Island Sound, and Delaware Bay and Raritan Bay, which lie within the boundary line between the State of New Jersey and the State of New York, as defined and established by an act of the legislature for that purpose, passed February 26, 1834, and within the boundary line between the State of New Jersey and the State of Pennsylvania, to wit: The middle line of the Delaware River and Delaware Bay, and also the shores thereof lying between high-water mark and low-water mark at ordinary tides are the property in fee simple of the State of New Jersey, by virtue of its prerogative right as a sovereign State; that in particular the said State of New Jersey is seized in fee of the ground and soil of all that part of the Delaware River surrounding the island known as Petty's Island, lying in the Delaware River opposite the city of Camden, from high-water mark at ordinary tides out to the middle line of the Delaware River, towards Pennsylvania, and from said middle line eastward to the fast land on the New Jersey shore; and that all of said Petty's Island is within the dominion of the State of New Jersey, and within the corporate limits of the township of Stockton, in the county of Camden; and that said State of New Jersey has a right of empire and government over the waters covering the said ground and soil, which waters are, and ever have been, navigable waters, and has full right and power to see to the navigation of said waters, and to prevent the erection of obstructions and nuisances in the said waters.

II. That by an act of legislature of the State of New Jersey, entitled "An act to ascertain the rights of the State and of the riparian owners in the lands lying under the waters of the bay of New York and elsewhere in the State," approved April 11, 1864, and the various supplements thereto, the said State of New Jersey has made provision for the use of the said ground and soil, and the waters covering the same, and has regulated the erection of piers, wharfs, bulk-heads, and other erections and permanent obstructions thereon and therein, so as to promote and conserve the public rights of navigation in said waters; and by its board of riparian commissioners, acting in pursuance of the provisions of the aforesaid acts and supplements, has established in the waters aforesaid a bulk-head line, for the permanent and solid filling up of said waters, and beyond which no such permanent and solid filling can lawfully be made; and, also, an exterior pier line, beyond which no pier or wharf can be lawfully made, and have vested in said board of riparian commissioners, together with the governor and attorney-general, the exclusive power to grant, lease, license, and regulate the use of said ground, soil and waters, and the erection of bulkheads, solid filling piers, wharfs, and other permanent erections and obstructions therein and thereon.

III. That between said "Petty's Island" [which is about two miles long] and the mainland is a large body of the river Delaware and a large and deep channel, navigable for large vessels, and having a depth at low tide, of over 20 feet; and that said channel is much used by vessels navigating the Delaware River, and by the inhabitants of this State, for the purpose of commerce and in the pursuit of their usual business and avocations; and that large shipyards and vessel-building establishments are located in Camden City, on said division of the Delaware River, and use and are interested largely in said channel; that the same is maintained and kept free from obstructions of any kind to navigation; and, further, that a large portion of the river Delaware now ebbs and flows between the New Jersey mainland and said "Petty's Island," and keeps the same free and clear, as it ever hath done.

IV. That Cooper's Creek, one of the boundary lines of the city of Camden, and a large stream of water, navigable and much used for navigation, lying wholly within the State of New Jersey, is tributary to the Delaware River, and empties therein in the aforesaid stream and channel.

V. That located on the bank of the Delaware River, at Pavonia, in the township of Stockton, in the county of Camden, are the water-works which furnish the entire water supply for the said city of Camden, and that said supply is drawn from the said Delaware River by pipes extending from a pier at said works directly into said river, and is pumped therefrom and stored in a reservoir erected for that purpose, directly east therefrom, on a high elevation of ground, and that said supply pipe, through which said water is pumped, opens into the river above the mouth of Cooper's Creek a considerable distance, and about one and a fifth miles below the upper end of said "Petty's Island," and in the aforesaid stream and channel, and that by reason of the free ebbing and flowing of such a large body of water between said "Petty's Island" and the mainland, as before mentioned, and as has heretofore been the case, the water supply of the city of Camden has been very pure and wholesome and of a very excellent character.

VI. That said water works are the property of the city of Camden, and, in addition to entirely supplying the said city, supply also some of the adjacent towns bordering on the city limits with water.

VII. That "the American Dredging Company," a corporation of the State of Pennsylvania, engaged in the business of making excavations and dredging in rivers, creeks, and harbors, has, since on or about the first day of August, been dredging and digging soil, mud, and dirt from the channel of the river Delaware, which extends along or near the western or Pennsylvania shore thereof, and dumping and depositing the same in said river at the upper or north end of said "Petty's Island," so as to continue the same out further into the aforesaid stream or channel flowing between said island and the New Jersey mainland, with the avowed purpose of making a solid wall of mud, dirt, and soil, in the nature of a dike, from said island to the New Jersey mainland; and that said company has been continuously at work since that time, and has deposited and dumped there soil and earth to the extent of from 800 to 1,000 cubic yards per day each and every day since about the first day of last August aforesaid; and that one John A. Bonker has already commenced, or is about to commence, to drive piles, and continue and complete said work of building said solid dike from said island to the New Jersey mainland, and that said earth and soil is now being dumped and deposited, and said piles are being, and are threatened to be, driven upon and in the ground and soil outside of the exterior bulkhead line and the exterior pier line, so as aforesaid established by law, and in and upon the ground and soil which is the property in fee of the State of New Jersey; and give out and pretend that they have the right and authority in law, and declare and assert that they intend, and are proceeding, to drive permanent piles and fill in sufficient soil and earth to build and construct so as to have entirely finished and completed, on or before the first day of November next, a solid, permanent, and substantial dike or wall of earth, to extend from the aforesaid upper end of "Petty's Island" to the New Jersey mainland, in order to turn the large body of water heretofore ebbing and flowing to the east of said "Petty's Island" in and through the aforesaid channel between said island and the New Jersey mainland, into the western or Pennsylvania channel aforesaid of said river, and that other persons, to your informant unknown, are assisting and contributing to the erection of said dike or wall, in order that when said dike is finished and completed, the said western or Pennsylvania channel will be deepened and widened, and the said eastern or New Jersey channel will be entirely closed.

VIII. That if the said above-mentioned plan and project is carried out and said dike or wall is built and erected, as is proposed to be done as aforesaid, that the use of said eastern or New Jersey Channel will be entirely destroyed, that the business and commerce of the inhabitants of this State, so as aforesaid carried on therein and thereon, will be destroyed, and that said ship-yards and vessel-building establishments now carried on in said city of Camden will be greatly injured and damaged, if not entirely extinguished and wiped out, and that the aforesaid Cooper's Creek, by the prevention of the free flowing of the present large body of water before the mouth thereof, will become filled up and rendered unfit for navigation; and in addition to the above-named damages and dangers, the building and finishing of said dike, as aforesaid, will cause a cove to form around and about the present supply-pipe for the aforesaid water-works of the city of Camden, wherein will be carried mud, refuse, and filth, at all times floating in and about the rivers having large cities upon their banks, which said mud, refuse, and filth carried and deposited in said cove by the flood tide will not be carried out by the ebb tide in said river, because there will be no free current of water flowing from above to force the same; so that the whole water supply of the said city of Camden will in a very short time become unwholesome, impure, and poisonous, and will create disease and cause damage and death among the inhabitants of this State in the city of Camden and elsewhere using said water, and the deposit of such mud, refuse, and filth would of itself create a nuisance prejudicial to the health of the inhabitants of this State.

IX. That there is no other or convenient place where works to supply the said city of Camden with water can be erected or maintained.

X. That the aforesaid actions and deeds of the said the American Dredging Company and John A. Bouker, and their associates, are contrary to law and without any warrant or authority whatsoever, and that said dike is being built without warrant or authority of law, and that the same is a public nuisance and obstruction to navigation, so far as the same has already progressed, and if permitted to continue to completion will be a much more serious obstruction to navigation, and that the same is a wanton invasion of the public property of the State, and will destroy the business and commerce of the citizens of this State, and will prove destructive of the purity of the water supply of the city of Camden, and render the same noxious and unwholesome, and cause damage, sickness, and disease in said city, destroying the public health and prove a public nuisance to the citizens of this State.

Your informant therefore prays that the said the American Dredging Company and John A. Bouker may answer and set forth the premises fully and particularly what has already been done by them, and each and every of them, and what is yet proposed to be done, and under what authority or pretended authority, and that the earth and soil already deposited as aforesaid, and piling driven, and other work done in the construction of the said dike as aforesaid, may be removed and the nuisance thereof be abated, and that the said defendants may be perpetually enjoined from further depositing any earth, soil, mud, dirt, stones, or other material, or driving any piles or doing any work, matter, or thing towards the construction of the aforesaid dike, or extending said island over from the north end thereof to the New Jersey mainland, or in anywise interfering with or obstructing said channel on the eastern or New Jersey side of said river Delaware, between said "Petty's Island" and New Jersey mainland, or in anywise interfering with, polluting, damaging, or destroying the source of the water supply of the said city of Camden, and that your informant may have such other and further relief as the nature and circumstances of the case may require, and as may seem agreeable to equity and good conscience.

May it please your honor, the premises considered to grant unto your informant not only the State's writ or writs of injunction issuing out of and under the seal of this honorable court, pursuant to the prayer aforesaid, but also the State's writ of subpœna, issuing out of and under the seal of this honorable court, directed to the said The American Dredging Company and John A. Bouker, therein and thereby commanding them and every of them, on a certain day and under a certain penalty therein to be expressed, to be and appear before this honorable court, then and there to answer fully the premises, but without oath or affirmation, which is hereby waived, and to stand, to abide, and perform such order and decree therein as to your honor shall seem meet and agreeable to equity and good conscience.

And your informant will ever pray, &c.

JOHN P. STOCKTON,
Attorney-General.

STATE OF NEW JERSEY, *Camden County, ss:*

John D. Leckner, of full age, being duly sworn according to law, on his oath saith, that he resides in the city of Camden, and the County of Camden, and State of New Jersey, and that he is a practicing physician in said city, that he is a member of the city council of the city of Camden from the fifth ward of said city, and is also chairman or presiding officer of the board of health of the said city of Camden, and that Petty's Island lies in the Delaware River north and west of the city of Camden partly, and partly of the township of Stockton, and is about two miles long, and is quite narrow; that the Delaware River divides at the head of said island, and one channel flows along the eastern or New Jersey mainland or bank and one on the western or Pennsylvania bank of said river; that said island is wholly within the limits of the township of Stockton, in the county of Camden, and State of New Jersey; that a large body of water flows between said island and the New Jersey mainland with the ebb and flood of the tide, and that said channel along said New Jersey is a large and deep channel, having a depth of 20 feet at low water, and navigable for large vessels, and is much used by the citizens of the State of New Jersey for the purpose of the carrying on of their business, and for commerce and navigation, and that large ship-yards and vessel-building establishments are located in the said city of Camden on said stream or channel, and make use of and employ the same in carrying on their said business; that Cooper's Creek, a large navigable stream of water, empties into said stream or channel; that said creek is much used for navigation; that the water-works which furnish the entire water supply for the city of Camden and some neighboring towns are located at Pavonia, in the said township of Stockton, on the mainland, opposite a point on said island about one and one-fifth miles below the upper or north end of said island, and that said water supply is drawn from said Eastern or New Jersey Channel, and that by reason of the ebb and flow of a large body of water through said channel and the depth thereof the water drawn therefrom has been very pure and wholesome, making the water supply of the city of

Camden exceptionally good for a large city; that there is no other available place where the water-works for the city of Camden could be located; that "The American Dredging Company" is now engaged in digging mud, earth, and soil from the Western or Pennsylvania Channel of said river, and dumping and depositing the same into said river from the end of said island at the north, in order to build a solid wall or dike from the north end of said island to the New Jersey mainland, so as to close up said Eastern or New Jersey Channel, prevent the ebb and flow of said large body of water between said island and New Jersey mainland, and divert the same to the Western or Pennsylvania Channel in order to broaden and deepen the same; that said company has been engaged in said work since on, or about the 1st day of August last past, and are depositing said mud, soil, and earth at the rate of 800 to 1,000 cubic yards per day, and have already done great damage to navigation and the water supply of the city of Camden; and that one E. L. Register has commenced or is about to commence to drive pilings so as to complete and strengthen said dike or wall, and it is the purpose of said company and said Register to build a solid, permanent, and substantial dike from the upper or north end of said island to the New Jersey mainland, so as to ruin and destroy the aforesaid New Jersey Channel, prevent the ebb and flow of the aforesaid large body of water, and ruin and destroy said ship-yards and vessel-building establishments, cause said Cooper's Creek to fill up and destroy its navigation, and create a cove or pool in which the flood of the tide will carry the mud, refuse, and filth always abounding in rivers on which are situate large cities and deposit the same in said cove and it will there remain, there being no force of water above to carry the same off at the ebb of the tide, so that in a very short time a large stagnant pool will be created, abounding in refuse and filth, from which the water supply for the city of Camden aforesaid must be drawn, and so cause said water to become noxious and unwholesome, and cause sickness, damage, and death to the citizens of the city of Camden and of this State, and destroy the health of the community; that said building of said dike is on the property of the State of New Jersey, is without any warrant or authority of law, and is an obstruction to navigation, and a public nuisance to the citizens of this State, and a destruction of their property and rights and of the public health; that the above-mentioned acts and purposes of said defendants, said company, and said Register have just come to the knowledge of this deponent; and deponent further saith that he has read the foregoing information, and that all the matters therein contained are true to the best of his knowledge and belief.

J. D. LECKNER.

Sworn and subscribed before me at Camden this 3d day of September, A. D. 1885.

N. G. STYRON, *M. C. C.*

STATE OF NEW JERSEY, *Camden County, ss:*

D. Cooper Carman, of full age, being duly sworn according to law, on his oath saith, that he is the city clerk of the city of Camden and the clerk of the board of health of said city; that he has read the foregoing information, and that the matters and things therein stated are true to the best of his knowledge and belief, and particularly are the matters and things stated and contained in the foregoing affidavit made by Dr. John D. Leckner, which deponent has carefully read, true.

D. COOPER CARMAN.

Sworn and subscribed before me at Camden this 3d day of September, A. D. 1885.

N. G. STYRON, *M. C. C.*

SCHEDULE B.—THE INJUNCTION.

New Jersey, to wit: The State of New Jersey to "The American Dredging Company" and E. L. Register, their workmen, servants, and agents, and each and every of them, greeting:

[SEAL.]

Whereas it hath been represented to us, in our court of chancery, on the part of the State of New Jersey of the attorney-general, John P. Stockton, that he hath lately exhibited his information against you, the said "The American Dredging Company" and E. L. Register, defendants, to be relieved touching the matters set forth in said information:

We, therefore, in consideration of the premises, and of the particular matters set forth in said information, do strictly enjoin and command you, the said "The American Dredging Company" and E. L. Register, your and each of your workmen, servants, and agents, and all and every the persons before mentioned, and each and every of you, under the penalty that may fall thereon, that you and every of you do absolutely desist and refrain from further depositing any earth, soil, mud, dirt, stones, or other material, or driving any piles, or doing any work, matter, or thing toward the construction of any dike or wall from the north end of Petty's Island over to the

New Jersey mainland, or extending said island over from the north end thereby to the New Jersey mainland, or in anywise interfering with or obstructing the Eastern or New Jersey Channel of the Delaware River flowing between said island and the New Jersey mainland, or in anywise interfering with, polluting, damaging, or destroying the source of the water supply of the said the city of Camden, until you, the said defendents, shall have fully answered the said information and our said court shall make other order to the contrary.

Witness his honor Theodore Runyon, our chancellor, at Trenton, the fourth day of September, in the year of our Lord one thousand eight hundred and eighty-five.

GEO. S. DURYEA,
Clerk.

JOHN P. STOCKTON,
Attorney-General.

SCHEDULE C.—THE ANSWER OF THE DEFENDANTS.

In the circuit court of the United States for the district of New Jersey, in the third circuit, September term, 1885. No. 5.

Answer of the American Dredging Company and John A. Bouker, defendants, to the bill of complaint of the attorney-general of the State of New Jersey, informant.

These defendants, now, and at all times hereafter saving and reserving unto themselves all benefit and advantage of exception which can or may be had or taken to the many errors, uncertainties, and other imperfections in the said informant's bill of complaint contained, for answer thereunto, and to so much and such parts thereof as these defendants are advised is or are material or necessary for them to make answer unto, answering, say:

I. That under the provisions of the act of Congress passed the 5th day of July, 1884, the sum of $200,000 was appropriated for the purpose of improving the Delaware River, from Trenton, New Jersey, to its mouth—continuing improvement. That the Delaware River is a part of the navigable waters of the United States connecting with the Atlantic Ocean, and lying between the States of Pennsylvania, New Jersey, and Delaware, and forms a continuous channel for commerce with foreign countries and among the States.

That a plan for the permanent improvement of the said river was recommended by a Board of Engineers of the United States Army, which said plan was approved and adopted by the Secretary of War of the United States, on the 2d day of May, 1885; that a part of said plan for the improvement of said river is the deepening of the channel thereof in front of the city of Philadelphia by the construction of a dike from Fisher's Point southward toward Petty's Island, for about 3,500 feet in length; that under the authority of the said act of Congress the said The American Dredging Company entered into a contract with the United States of America, on the 29th day of July, 1885, and the said John A. Bouker, on the 7th day of August, 1885, to build and construct said dike, and that in pursuance of said contract, and under the superintendence of Henry M. Robert, lieutenant-colonel of Engineers, of the Army of the United States, and under the authority and direction of the Secretary of War, the said defendants were proceeding to construct said dike aforesaid, which is the matter complained of in said bill; that other than as said contractors aforesaid, acting under the supervision and direction of the Secretary of War of the United States, as before stated, the defendants in the above case have done no act whatever touching the matter complained of in said bill.

II. These defendants aver that under the provisions of the act of Congress aforesaid, and under the authority and direction of the Secretary of War as aforesaid, they have been duly authorized, and have the right to proceed to perform the work and to construct the aforesaid dike in the said Delaware River; without this, that any other matter or thing whatsoever in said bill of complaint contained, material or effectual in the law to be answered unto, and not herein and hereby well and sufficiently answered unto, confessed and avoided, traversed or denied, is true, all of which matters and things these defendants are and will be ready to aver, maintain, and prove, as this honorable court shall direct, and pray to be hence dismissed with their costs and charges in this behalf, most wrongfully sustained.

AMERICAN DREDGING COMPANY.
ISAAC ALBERTSON,
President.

Attest:
FLOYD H. WHITE,
[SEAL.] *Secretary.*
Witness:
CHAS. DAY.

JOHN A. BOUKER.

improvement contemplates a dike from Fisher's Point, on the New Jersey shore, to a point in the Delaware River, running about 3,500 feet.

The city of Camden and the shore-owners, believing that this work would divert what is now the main channel of the Delaware River at that point, and throw it entirely on the Pennsylvania side, to the disadvantage of all property, and to the damage of the water used by the citizens of Camden, applied for and obtained a temporary injunction restraining the work.

I have examined into the matter of late, and find, from the opinion of those accustomed to the tides and the action of the river in this locality, that this work, if carried out, will result in the following damage to the interest on the New Jersey shore:

1st. It would destroy the channel on this side, making shoal water on a very extensive river-front, and of what is now the ship-channel;

2d. It will, eventually, have the effect of filling up the navigable stream of Cooper's Creek. on which there is a large number of factories;

3d. It interferes with the private rights of people who own land there, and particularly those firms engaged in the manufacture of brick, which is a large industry in this locality. At what is known as "Fish House," this work, if carried out, would utterly destroy their water communication; and

4th. What excites the attention of the citizens most, is the possible destruction of our water supply, which is taken from the water that would be shoaled by the action of this dike.

Presuming that our State courts will not have the jurisdiction to prevent the Department from carrying out a public improvement of this kind, I beg that before the work is renewed the board of officers that adopted the plan be re-convened, or a similar one created to take into consideration the points named by me. Our citizens are very much excited in relation to the matter, and your compliance with my request would be gratifying to them.

Very respectfully, yours,

W. J. SEWELL,
U. S. S.

Hon. W. C. ENDICOTT,
Secretary of War.

REPORT OF LIEUTENANT-COLONEL HENRY M. ROBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., October 9, 1885.

SIR: I have the honor to submit the following remarks upon the letter of Hon. W. J. Sewell to the honorable the Secretary of War, referred to me by your indorsement, dated October 3, 1885:

The dike complained of is to extend from Fisher's Point, New Jersey, 3,000 feet toward the head of Petty's Island, with a mattress sill about 3 feet thick, projecting 500 feet farther, leaving an open channelway of about 3,000 feet between the end of the sill and the island, or 3,500 feet between the end of the dike and the island. The top of the dike is to be at the level of mean low water, allowing the tides to flow over it. The dike will cut off the least important of the two channels between Fisher's Point and Petty's Island.

The dike is a portion of the plan of the Board of Engineers on the permanent improvement of the Delaware River appointed last year, and is evidently designed to throw more water into the channel west of Petty's Island. The project for its construction was approved by the honorable the Secretary of War, May 2, 1885, and contracts were made under which work was commenced on the dike last August, but an injunction served on the contractors September 4, put a stop to the work. The case is now before the United States circuit court. When stopped the condition of the work was as follows: The contractors for dredging west of Petty's Island had placed about 26,000 cubic yards of gravel on the line and in the vicinity of the dike, being about one-third of their contract. The contractors for building the dike had, I understand, large quantities of brush cut at various points, and had arrangements completed, they claimed, to deliver material and put in 100 feet of dike per day within a week of the time when they were stopped, but they had not yet put any material into the water.

The objections to the dike, as stated in the letter referred to me, are four in number, and my remarks will be in the same order as the objections.

(1) Objection: "It would destroy the channel on this side, making shoal water on a very extensive river-front, and of what is now the ship-channel."

Remarks: The object of the dike is to throw more water into the channel west of Petty's Island, and it will undoubtedly diminish the flow east of the island, but I cannot see that this diminution will produce the disastrous effects claimed.

(2) Objection: "It will eventually have the effect of filling up the navigable stream of Cooper's Creek, on which there is a large number of factories."

Remarks: It seems to me that the effect of the dike on Cooper's Creek would be just the opposite to the one here mentioned. In order to see the effect, let us suppose the dike to be built entirely over to Petty's Island, and to be raised above high water. We would then have a cul-de-sac in which the flood tide would rise higher than at present, forcing an increased amount of water up Cooper's Creek, and thus increasing the working force of the ebb tide, tending to scour out the creek to an increased depth. In so far as the dike will have any effect upon Cooper's Creek, it will, in my opinion, be to improve the creek by increasing the working force of the tide in the creek.

(3) Objection: "It interferes with the private rights of people who own land there, and particularly those firms engaged in the manufacture of brick, which is a large industry in this locality at what is known as 'Fish House.' This work, if carried out, would utterly destroy their water communication."

Remarks: Every improvement of this nature necessarily interferes with private rights. In the course of time it is to be expected that the area immediately behind the dike will be partially filled up and the deep water be further removed from the present shore. At present it is difficult to foresee what damages may result to owners of adjacent lands, but it would seem only equitable that they should be fully recompensed for any actual damage suffered from the construction of the dike.

(4) Objection: "What excites the attention of the citizens most is the possible destruction of our water supply, which is taken from the water that would be shoaled by the action of this dike."

Remarks: Even supposing that the dike would destroy the water supply of Camden or Philadelphia, it would be a question as to whether the use of great navigable rivers for supplying the water-works of cities should take the precedence of their use for navigation. If the dike causes the extensive shoaling feared by the authorities of Camden, it would be a question whether it would not be a blessing in disguise to the water-works by preventing the construction of manufactories between the water-works and the dike, which would probably pollute the river more than the shoals.

But while the dike must necessarily reduce the amount of water flowing through this channel, and therefore produce some shoaling, and I suppose all shoaling has some effect upon the purity of the water, yet it seems to me this effect of the dike will be so small as to scarcely enter as a formidable factor in the problem of how to improve this portion of the Delaware River. When the effect of the dike is compared with the effect of running out solid piers to the wharf lines on either side of the channel, as shown on the accompanying chart, and of the construction on the shores of factories which, as stated in the second objection, are already numerous on Cooper's Creek, the mouth of which is only 800 yards from the water-works, both of which in time are to be expected in such near vicinity to cities like Camden and Philadelphia, it would seem that the results from the construction of the dike would be no worse than would be expected from other improvements naturally to be expected in the vicinity of large cities.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

SCHEDULE F.—SPECIAL REPORT OF BOARD OF ENGINEERS.

ENGINEER OFFICE, U. S. ARMY,
Philadelphia, Pa., October 28, 1885.

GENERAL: The Board of Engineers constituted by Special Order 177, Headquarters Corps of Engineers, series of 1884, for the purpose of preparing a plan for the permanent improvement of the Delaware River from Trenton, N. J., to Delaware Bay, and re-convened by Special Order 167, Headquarters Corps of Engineers, October 22, 1885, for the purpose of considering certain objections made by citizens of Camden, N. J., to the construction of a dike which the Board had recommended, beginning at Fisher's Point, New Jersey, 3 or 4 miles above Camden, and extending about 3,000 feet towards the head of Petty's Island, have the honor to report as follows:

REPORT.

The Board met at the United States Engineer Office in Philadelphia on Monday, October 26, the day appointed. Present, all the members.

After the reading of the papers submitted for their consideration by the Chief of Engineers, Senator Sewell, of New Jersey, Mr. Armstrong, Mr. Dialogue, Dr. Leckner, and others personally appeared before the Board and made oral statements of the damage which they believed the interests they represented would sustain by the completion of the projected dike. These statements indicated great opposition to the work; and in order that a more general and convenient hearing might be given to the citizens of Camden, N. J., it was arranged that a public meeting should be held at ten o'clock on the following morning, at the office of Senator Sewell, in that city, which all interested persons should be invited to attend, for a full and detailed presentation of their views.

Tuesday, October 27.—The Board met at the time and place appointed, and heard the testimony of all who wished to appear before them; after which, in company with many of the citizens interested, they visited and examined the site of the proposed work and the New Jersey

Channel. On their return to Philadelphia, the same afternoon, Mr. Browning appeared before the Board, and gave oral testimony concerning the fishing interest that would be affected by the proposed work at Fisher's Point. After discussing the testimony which had been offered, and agreeing upon their report, the Board adjourned, having first learned, in consultation with the local engineer, that there was no other question of improvement which needed their attention at this time other than the one especially referred to them by the Chief of Engineers.

At the session held at Senator Sewell's office the following gentlemen appeared and presented their objections to the proposed construction, namely:

1. Augustus Reeve, representing the brick-yard interests.
2. J. B. Wood, representing the ship-yard interests.
3. Captain John B. Adams, shipmaster.
4. Mr. Dialogue, councilman, water committee.
5. N. J. Meade, State board of health.
6. Mr. Bacot, engineer, riparian commission.
7. John S. Shultz, city surveyor.
8. H. M. Birkenbine, C. E.
9. Charles G. Darrach, C. E.
10. Senator Sewell, of New Jersey.

The following spoke in favor of the work:

1. Representative Charles O'Neil, of Philadelphia.
2. Mr. Tucker, port warden of Philadelphia.

Many others were present on both sides, but did not present their views.

The objections offered to the prosecution of the work are based upon the fear that it will damage—

(1) The brick-yard property and the fishery at Fisher's Point, by causing the water to shoal in front of these yards, lying just below Fisher's Point, which would compel the extension of their wharves or landing places.

(2) The ship-yard property, by causing the shoaling of the water in front, which might result in destroying their business.

(3) Cooper's Creek, where now there is a large amount of commerce, by causing its mouth to fill up.

(4) The water supply of the city of Camden, by reducing the flow of water through the New Jersey Channel to such an extent that a marsh would gradually form behind the dike, which would catch sewage and other impure matter that would otherwise float away, and thus the city water, which is taken out of this channel, would be rendered unfit for use, and the water-works would therefore have to be removed, at a cost of $1,000,000 probably.

(5) The health of the city, in the same way, by the formation of this marsh, which would produce malaria.

After careful consideration of the subject, the Board cannot bring themselves to view these objections in the serious light in which they seem to be regarded by the gentlemen who presented them; and it appears to be more than probable that much of the importance which has been attached to them has arisen from the belief that the contemplated dike was to be (as was erroneously stated in the information laid before the chancellor of the State of New Jersey, upon which an injunction was obtained) a solid high-water dike extending from Fisher's Point to the head of Petty's Island, completely closing the channel. On the contrary, the proposed dike is to be a low-water dike over which the tide will ebb and flow partially, and it is to extend only about half way across the opening between Fisher's Point and Petty's Island.

It is probable that in the cove formed between this dike and the mainland a deposit will take place which may finally result in filling it up, and in this way the brick-yard and other property may be affected, but whether favorably or unfavorably time only will determine.

It is not believed, however, that the work proposed will reduce the volume of water which now passes through the New Jersey channel to such an extent as to affect injuriously any of the other interests referred to.

Should the time ever arrive when, through changes in the regimen of the river, it would become necessary to close this channel completely, in order to preserve the main channel, some of the evils now feared might follow, but this is a distant contingency, and in the event of its occurrence Congress would doubtless be willing to afford relief for the local damage which the general interests of commerce and navigation may have made it necessary to inflict.

It does not appear to the Board that there are any other means available of successfully maintaining the requisite channel depth in this part of the Delaware River than those which they have heretofore proposed, and they recommend, therefore, that the construction of the Fisher's Point Dike be continued and completed.

WM. P. CRAIGHILL,
Lieut. Col. of Engineers.
WALTER MCFARLAND,
Lieut. Col. of Engineers.
G. L. GILLESPIE,
Major of Engineers.
W. H. HEUER,
Major of Engineers.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

LETTER OF LIEUTENANT-COLONEL WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., October 31, 1885.

GENERAL: In sending forward herewith the report of the Board on the permanent improvement of the Delaware River, dated October 28, 1885, it seems not out of place to call attention to the following points, which may be worth consideration:

1. The dike to which opposition has been made is to be to the height of low water. The law of New Jersey already allows the introduction of a structure for a considerable portion of the length of this dike to the level of high water, or higher if the riparian owner should so desire, and this not only on the line of the proposed dike, but along the whole shore of the large cove below it.

It is hence obvious that a much larger interference is thus authorized by the laws of New Jersey with the tidal reservoir on the New Jersey side of Petty's Island than may be reasonably expected from the low dike of the Board from Fisher's Point.

2. The plan of improvement, of which the dike is an important part, contemplates the maintenance of a channel on the Philadelphia side of

Petty's Island of 26 feet at low water, or about 32 feet at high water, and this is the standard of the depth to be attained throughout the whole length of the river below to its mouth. The movement of the tidal wave up the river will then be much facilitated. An increase of the average height of the flood tide may be expected above Petty's Island, due to the causes below it, which have been indicated, and consequently there will be an increase in the volume of disposable water above Petty's Island. This will be still greater when the channel is deepened as expected between Philadelphia and Trenton.

Under these circumstances, while it is admitted that the dike from Fisher's Point will have the effect of deflecting a certain portion of the ebb tide towards the Philadelphia side, it is reasonable to believe the loss to the New Jersey side will not be material after the expected increase of depth is attained above and below Petty's Island.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Lieut. Col. of Engineers.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., November 6, 1885.

SIR: I have the honor to submit the inclosed copy of the Report of Board of Engineers reconvened with your sanction by Special Orders 167, Headquarters Corps of Engineers, dated October 22, 1885, to consider and report upon certain objections urged by the Hon. W. J. Sewell, United States Senator from New Jersey, and others, to the proposed low-water dike now in course of construction between Fisher's Point and Petty's Island, in the Delaware River above Camden, N. J.

It will be seen that the Board has given patient consideration to the objections urged by the citizens of Camden, many of whom presented their views in person, and report that they "cannot bring themselves to view these objections in the serious light in which they seem to be regarded by the gentlemen who presented them, and it appears to be more than probable that much of the importance which has been attached to them has arisen from the belief that the contemplated dike was to be (as erroneously stated in the information laid before the Chancellor of New Jersey, upon which an injunction was obtained) a solid high-water dike extending from Fisher's Point to the head of Petty's Island, completely closing the channel. On the contrary, the proposed dike is to be a low-water dike, over which the tide will ebb and flow partially, and it is to extend only about half way across the opening between Fisher's Point and Petty's Island."

The Board further remarks that it does not appear "that there are any other means available of successfully maintaining the requisite channel depth in this part of the Delaware River" * * and recommends "that the construction of the dike be continued and completed."

The views of the Board are concurred in and recommended for approval.

In this connection, attention is respectfully invited to the letter of Lieut. Col. W. P. Craighill, Corps of Engineers, President of the Board, dated the 31st ultimo, submitting the report.

Previous papers herewith.

Very respectfully, your obedient servant,

JOHN NEWTON,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

Hon. WM. C. ENDICOTT,
Secretary of War.

WAR DEPARTMENT, *November* 9, 1885.

Approved.

By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

REPORT OF LIEUTENANT-COLONEL HENRY M. ROBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., February 20, 1886.

SIR: In compliance with your indorsement of the 12th instant, on the letter of Mr. W. R. Tucker, I have the honor to submit the following report with estimate of the cost of improving the channel over Smith's Island Bar in the Delaware River.

Smith's Island Bar lies in the middle of the Delaware River between Philadelphia, Pa., and Camden, N. J. It is about 1½ miles in length between the 6-foot curves and covers about three-fourths of the water front of Camden. The mass of the commerce that crosses the river from Pennsylvania to New Jersey at Philadelphia must cross this bar, which at mean low tide does not afford a channel of 2 feet depth. The United States spent $10,000 in 1883–'84 in dredging a channel of 10 feet depth across this bar just above Smith's Island, but it has since filled up, so that I understand there is not now more than 2 feet at low water at this locality. A narrow canal has been cut and maintained between Smith's and Windmill islands, which form a part of this bar, by the ferry companies.

The channel formerly dredged by the United States and the narrow canal maintained in the interest of the ferry companies have both been cut at right angles to the general axis of the river, and therefore could not be kept open by the currents.

On the accompanying tracing is shown the location of the cut across this bar that I would propose as the best solution of the problem. The ebb current would help keep it open, while the flood would not injuriously affect it. I would aim at maintaining a low-water channel of 10 feet depth and at least 200 feet wide, and would therefore propose to dredge a channel of 200 feet width to a depth of 12 feet, and to protect this channel by a simple revetment.

The estimated cost of this work is $40,000, of which $20,000 is for dredging 100,000 cubic yards of sand, and the remainder for constructing 2,000 feet of revetment. The entire amount should be appropriated at one time.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

COMMERCIAL STATISTICS.

(Above Philadelphia.)

Vessels arriving at and departing from the Delaware and Raritan Canal at Bordentown during the year ending December 31, 1885.

Description.	Arrivals.			Departures.		
	Number.	Tonnage.	Average crews.	Number.	Tonnage.	Average crews.
Steamers	770	91, 553	8	741	75, 301	8
Sailing vessels	154	23, 369	8	7	452	8
Barges	2, 831	502, 262	2	1, 727	210, 635	2
Rafts	89	5, 302	2	1	68	2
Totals	3, 844	622, 486	....	2, 476	286, 456	....

A total of 6,320 loaded vessels carrying 908,942 gross tons of freight. The estimated value of shipments arriving, 622,486 tons, was $12,724,908, and that of departing, 286,456 tons, at $9,259,823, a total of $21,984,731.

The canal collector at Bordentown estimates the tonnage by water, to and from Bordentown, for the year ending December 31, 1885, not entering the canal and therefore not included in above statement, at 227,000 gross tons. This would make the aggregate tonnage of the Delaware River at Bordentown 1,135,942 tons.

In addition to the foregoing, several steamboats run daily during the season of navigation between Philadelphia and points on the river above, carrying a large number of passengers and considerable freight.

The above information was furnished by Mr. G. M. Taylor, auditor of freight receipts, Pennsylvania Railroad Company.

Statement of tonnage over the piers of the Philadelphia and Reading Railroad Company, on the Delaware River Front, at Port Richmond, during the year ending December 31, 1885.

	Tons.
Anthracite coal	1, 777, 522
Other merchandise, including 2,827,789 bushels of grain	450,000
Total	2, 227, 522

Estimated statement of vessel movement to and from Port Richmond piers during the year ending December 31, 1885.

	Vessels.
For movement of coal	7, 463
For movement of grain	284
For movement of general merchandise	366

The above information was furnished by Mr. Frederick W. Taylor, of the Philadelphia Grain Elevator Company.

Domestic and foreign entrances and clearances, 1885.

(Below Philadelphia.)

With and without cargoes.	With cargoes.		With ballast.	
	Vessels.	Tons.	Vessels.	Tons.
American vessels entered from foreign ports	433	210, 023	4	3, 560
American vessels cleared for foreign ports	269	153, 764	18	6, 359
Foreign vessels entered from foreign ports	743	770, 958	107	92, 634
Foreign vessels cleared for foreign ports	763	771, 997	25	23, 241

Coastwise entrances and clearances, 1885.

Class of vessels.	Entered.	Cleared.
Steamers	1,633	1,707
Ships	25	9
Barks	42	58
Brigs	20	48
Schooners	3,008	2,914
Total	4,728	4,736

Export of grain and petroleum during 1885.

Wheat	bushels	3,369,905
Corn	do	6,028,564
Petroleum	barrels	2,968,120

The above information was furnished by the Philadelphia Maritime Exchange.

F 2.

IMPROVEMENT OF DELAWARE RIVER AT SCHOONER LEDGE, PENNSYLVANIA AND DELAWARE.

No work was done at this locality during the past fiscal year. The appropriation of $40,000, August 2, 1882, was the last made specifically for this work, and available funds were practically exhausted during the working season of 1884. The total amount expended has been $170,000, and has resulted in the formation of a channel 330 feet wide and 24 feet deep at mean low water through the rocky ledge.

The improvement of this locality is considered in the Report of the Board of Engineers of 1884 for the permanent improvement of Delaware River and Bay, and will be found in the Report of the Chief of Engineers, 1885, page 822. This report shows that to obtain at this locality a channel 600 feet wide and 26 feet deep, at mean low water, would require the removal of about 20,000 cubic yards of rock and 46,133 cubic yards bowlders, gravel, and sand, at an estimited cost of $449,063.

The improvement of Schooner Ledge should form a part of the comprehensive plan for the permanent improvement of the Delaware River, as recommended by the Board of Engineers of 1884, and no appropriation is asked for under the above title, since it is for the best interests of the work and of commerce that all funds for the improvement of the main ship-channel of the river be appropriated under the general title of "Improvement of Delaware River from Trenton, N. J., to its mouth."

This work is situated in the collection district of Philadelphia, which is the nearest port of entry. The amount of revenue collected at that port during the year ending December 31, 1885, was $13,801,190.61. The nearest fort and light-houses are, respectively, Fort Mifflin and the Schooner Ledge range lights.

Total appropriations to June 30, 1886	$170,000 00
Total expenditures to June 30, 1886	170,000 00

Money statement.

July 1, 1885, amount available	$162 93
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	162 93
Amount (estimated) required for completion of existing project	(*)

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*Included in amount required for completion of existing project, "Delaware River from Trenton, N. J., to its mouth."

F 3.

IMPROVEMENT OF DELAWARE RIVER NEAR CHERRY ISLAND FLATS, DELAWARE.

No work was done at this locality during the past fiscal year. The appropriation of $100,000 of August 2, 1882, was the last made specifically for this work, and available funds were practically exhausted during the working season of 1883. The amount expended has been $400,000, and was applied to the formation of a dredged channel about 2 miles long, 470 feet wide, and 24 feet deep at mean low water.

The improvement of this locality is considered in the Report of the Board of Engineers of 1884 for the permanent improvement of Delaware River and Bay, and will be found in the Report of the Chief of Engineers, 1885, page 822. This report shows that to obtain at this locality and through the shoal water in its vicinity a channel 600 feet wide and 26 feet deep at mean low water would require the removal of about 828,200 cubic yards of sand and mud, at an estimated cost of $248,460.

The improvement of Cherry Island Flats should form a part of the comprehensive plan for the permanent improvement of the Delaware River as recommended by the Board of Engineers of 1884. No appropriation is asked for under this title, as it is for the best interests of the work and commerce that all the funds for the improvement of the channel of the Delaware River be appropriated under the general title of "Improvement of Delaware River from Trenton, N. J., to its mouth."

This work lies in the collection district of Delaware, with Wilmington as its nearest port of entry, at which the revenue collected during the year ending December 31, 1885, amounted to $12,573.93. The nearest fort and light-houses are respectively Fort Delaware and Cherry Island range lights.

Total appropriations to June 30, 1886	$400,000
Total expenditures to June 30, 1886	400,000

Money statement.

July 1, 1885, amount available	$1,456 74
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,456 74
Amount (estimated) required for completion of existing project	(*)

F 4.

IMPROVEMENT OF FRANKFORD CREEK, PENNSYLVANIA.

No work was done on Frankford Creek during the last fiscal year, and no appropriation for its improvement has been made since that of August 2, 1882, appropriating $10,000. This amount was practically expended during the fiscal year ending June 30, 1883, in the formation of a dredged channel 7 feet deep at mean low water, and extending from the mouth of the creek to above Bridge Street Bridge, Bridesburg.

This creek is entirely within the corporate limits of Philadelphia, and it is understood to be regulated by the municipal authorities. It is not

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[*] Included in amount required for completion of existing project, "Delaware River from Trenton, N. J., to its mouth."

considered in the interest of commerce and navigation to recommend further appropriations.

Frankford Creek lies wholly within the port of entry of Philadelphia, at which the revenue collected during the year ending December 31, 1885, amounted to $13,801,190.61. The nearest fort and light-houses are, respectively, Fort Mifflin and Horseshoe range lights.

Total appropriations to June 30, 1886	$10,000 00
Total expenditures to June 30, 1886	9,735 50

Money statement.

July 1, 1885, amount available	$557 17
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	292 67
July 1, 1886, amount available	264 50
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	30,000 00

COMMERCIAL STATISTICS.

Arrivals and departures of vessels during the year ending December 31, 1885.

Description.	Arrivals.		Departures.	
	No.	Tonnage.	No.	Tonnage.
Sailing vessels	44	6,600	44	6,600
Barges	6	900	6	900
Totals	50	7,500	50	7,500

Imports.

Articles.	Quantity.	Value.
Lumber ... feet	1,000,000	$7,500
Wood ... cords	800	4,000
Sand ... tons	2,700	4,000
Soda ash ... do	500	15,000
Hay ... do	300	1,500
Total	....	32,000

The above information was furnished by the Mason Fruit Jar Company, of Bridesburg.

F 5.

IMPROVEMENT OF SCHUYLKILL RIVER, PENNSYLVANIA.

Under a contract with the National Dredging Company, dated October 6, 1884, 36,004 cubic yards were removed during the fiscal year from the river between Point Breeze and Girard Point piers. This contract was completed July 31, 1885, by the aggregate removal of 88,734 cubic yards, at 28 cents per cubic yard.

The work done was applied towards obtaining a low-water depth of 20 feet for a width of 250 feet on that part of the river under improvement between Girard Point and Gibson's Point, and in accordance with the approved project.

The appropriations for the improvement of this river began in 1870, and have been applied to the deepening and widening of the natural channel by dredging, so that at present the river has an improved channel 300 feet wide and 24 feet deep from its mouth to Girard Point, a distance of about 1 mile; a channel from 150 to 200 feet wide and 20 feet deep from Girard Point to Gibson's Point, a distance of 3 miles; and a channel 150feet wide and 18 feet deep from Gibson's Point to Chestnut street.

The natural character of the banks and the bed and the tidal characteristics of the river are such as to render quite permament the improved channels.

The work which has been done is of great benefit to commerce, and the further improvement of the river to the completion of the existing project would be of great advantage.

During the fiscal year ending June 30, 1887, available funds will be applied to dredging.

An appropriation of $75,000 is recommended for the fiscal year ending June 30, 1888, and if an appropriation is made it will be applied to dredging in furtherance of the approved project.

Total appropriations to June 30, 1886	$350,000 00
Total expenditures to June 30, 1886	349,615 38

This work lies in the collection district of Philadelphia, at which, as a port of entry, there was collected during the year ending December 31, 1885, revenue to the amount of $13,801,190.61. The nearest fort and light-houses are, respectively, Fort Mifflin and Schuylkill River range lights.

Money statement.

July 1, 1885, amount available	$11,578 97
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	11,194 35
July 1, 1886, amount available	384 62
Amount appropriated by act approved August 5, 1886	18,750 00
Amount available for fiscal year ending June 30, 1887	19,134 62
Amount (estimated) required for completion of existing project	116,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	75,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Amount of tonnage to and from Schuylkill River and passing in and out of the Delaware and Raritan Canal at Bordentown, for the year ending December 31, 1885.

	From Schuylkill River.	To Schuylkill River.
	Tons.	*Tons.*
Coal	247,156	25,452
Miscellaneous merchandise	17,027	17,826
Total	*264,183	†43,278

* Carried by 1,457 canal-boats. † Carried by 368 canal-boats.

The above information was furnished by Mr. G. M. Taylor, auditor freight receipts, Pennsylvania Railroad Company.

Number of vessels and estimated shipments of petroleum from Gibson's Point during the year ending December 31, 1885.

Ships	16
Barks	69
Brigs	1
Schooners	2
Barges and sloops	10
Total vessels	98
Total barrels	238,902

Number of vessels at Point Breeze and total shipments of petroleum during the year ending December 31, 1885.

Steamships	5
Ships	124
Barks	345
Brigs	12
Schooners	37
Barges and sloops	32
Total vessels	555
Total barrels	2,170,643

Number of vessels at and shipments of grain from Girard Point elevators during the year ending December 31, 1885.

Steamships	63
Ships	1
Barks	16
Schooners, sloops, and barges	211
Total vessels	291
Total bushels grain	6,564,643
Total tons merchandise	27,475

Number of vessels arriving at the wharves of the Knickerbocker Ice Company, John Baird & Sons, G. F. Parker, and Harrison Brothers & Co., on Schuylkill River, during the year ending December 31, 1885.

Barks	11
Brigs	2
Schooners	150
Total	163

Carrying—	Tons.
Brimstone and clay	3,734
Ice	71,549
Marble	15,320
Stone	2,466
Total	93,069

The above information was furnished by Messrs. Peter Wright & Sons, of Philadelphia, Pa.

F 6.

ICE-HARBOR AT MARCUS HOOK, PENNSYLVANIA.

Under an agreement with the American Dredging Company, dated November 16, 1885, 34,000 cubic yards of material, at 20 cents per cubic yard, were removed by dredging from the area between the first and second and the second and third pairs of ice-piers. The dredging between the first and second pairs of piers was to a depth of 22 feet, and that between the second and third pairs of piers to a depth of 24 feet below mean low water. The deepened area extended to lines about 25 feet inside of the inner faces of the ice-piers. This dredging renders about two-thirds of the area of the harbor protected by the piers available for vessels drawing from 22 to 26 feet at mean low water.

Under an agreement with Messrs. Davis, Irvin & Sauville, dated November 24, 1885, and for the sum of $298, two groups of mooring piles were placed in the harbor. These groups of piles were placed on the line of the inner ice-piers, one group being midway between the first and second pairs of piers, and the other group midway between the second and third pairs of piers. The distance between the piers on these lines was about 600 feet, and experience had shown that the distance was too great between mooring points. These groups of piles reduce the distance between mooring points to about 300 feet, and are found to add greatly to the value of the harbor.

This harbor is of considerable value to the commerce of the river during the winter season, and at times is filled to its full capacity. Its utility will continue even when the proposed ice-harbor at the head of Delaware Bay is built, since the ice-harbor at Marcus Hook will always be valuable as a refuge for vessels in the upper part of the river.

The inner pier of the third pair shows signs of instability, and may require in the near future extensive repairs. The value of the harbor to vessels seeking temporary refuge from ice is somewhat reduced from the practice of vessel-owners utilizing the harbor as a place in which their vessels are permanently placed during the winter season. This practice, while it enables the owners of such vessels to escape dock and wharf charges, incumbers the harbor unnecessarily, and there should be such legislation as would give the United States authority to appoint a harbor-master, with power to control the harbor.

Available funds were entirely exhausted during the past fiscal year.

During the fiscal year ending June 30, 1888, if funds are available they will be applied to the construction of the bulkhead along the shore front of the harbor and in deepening by dredging the shoal areas of the harbor in accordance with the present project for its improvement.

It is located in the collection district of Philadelphia. This is the nearest port of entry, the collections during the year ending December 31, 1885, amounting to $13,301,190.61. The nearest fort and light-house are, respectively, Fort Mifflin and Christiana Light.

Total appropriations from 1866 to June 30, 1886	$179,000
Total expenditures from 1866 to June 30, 1886	179,000

Money statement.

July 1, 1885, amount available	$7,438 16
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	7,438 16
Amount appropriated by act approved August 5, 1886	15,000 00
Amount (estimated) required for completion of existing project	35,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	35,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for dredging at the ice-harbor at Marcus Hook, Pa., received in response to circular-letter, and opened November 16, 1885, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Price per cubic yard.	Remarks.
		Cents.	
1	American Dredging Company, Philadelphia, Pa	20	Accepted.
2	William C. Turner, Philadelphia, Pa	22	
3	National Dredging Company, Wilmington, Del	20½	
4	Frank C. Somers, Philadelphia, Pa	21	

Abstract of proposals for placing two groups of mooring piles at the ice-harbor at Marcus Hook, Pa., received in response to circular-letter, and opened November 24, 1885, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Price.	Remarks.
1	Davis, Irvin & Sauville, Philadelphia, Pa	$298	Accepted.
2	Henhoeffer & Vaughn, Wilmington, Del	450	
3	J. Powell & Son, Philadelphia, Pa	350	

F 7.

ICE-HARBOR AT HEAD OF DELAWARE BAY, DELAWARE.

The act of August 2, 1882, contained an appropriation of $25,000 for "ice-harbor at head of Delaware Bay, and for removal of sunken piers in channel back of Reedy Island, Delaware." The sum of $3,700 was expended in 1883 in removing the sunken piers at Reedy Island, and $3,800 in surveys and examinations, leaving an available balance of $17,500 at the commencement of the last fiscal year, of which nothing has since been expended.

The importance of this ice-harbor has been fully set forth in previous reports, but the difficulties connected with it are so great that I do not think there has yet been any satisfactory solution proposed. From all the information I have obtained, the inclosing of the area by a barrier that will prevent the ingress and egress of ice will be no improvement upon the plan of detached ice-breakers, as heretofore used in this river. But the question of the most economical construction for the ice-breakers, whether they should be stone piers, pile-piers, or floating pontons, requires more study than has yet been given to the subject.

It is hoped that a report with plans and estimates may be submitted during the ensuing fiscal year.

Money statement.

July 1, 1885, amount available	$17,500 00
July 1, 1886, amount available	17,500 00
Amount (estimated) required for completion of existing project	381,090 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

SPECIAL REPORT OF LIEUTENANT-COLONEL HENRY M. ROBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., November 28, 1885.

SIR: I have the honor to submit the following objections to the special plan of an ice-harbor at Liston's Point, Delaware River, referred to me for report February 14, 1885.

The plan appears to be a modification of the method of two parallel piers perpendicular to the shore, the modification consisting in curving the piers so as to bring the outer ends about one hundred yards apart, this opening forming the entrance to the harbor.

Each pier consists of a series of small iron pile-piers connected by an iron railing, supported at intervals by single iron piles. The railing is sufficiently close and high to prevent the ice from floating through it.

The fundamental idea of the plan appears to be to keep out of the harbor all extraneous ice. This is a great advantage if not obtained at too great cost. Is not the cost, however, greater than the benefit? In order to keep out the extraneous ice it is necessary to confine the inside ice, so that, though repeatedly broken up by the ice-boats, instead of being driven out of the harbor by the current, as at the present ice-harbors on the Delaware River, it would remain to become solid again. It would seem but natural that the ice inside the harbor should be much thicker than what is outside, and prove a serious hindrance to the use of the harbor; but in order to keep out the extraneous ice by a railing it is necessary to make the much more serious sacrifice of suitable entrances to the harbor, leaving only one entrance, and that on the side, so that vessels will have to enter and leave the harbor across the current.

There would be no special objection to the entrance provided it were the entrance to a river, like the harbors on our Northern Lakes. In such case a vessel could approach at full speed on the line of the axis of the entrance with safety, for she would, after entering, have sufficient time to slow down before reaching the harbor proper where vessels lie. But in the ice-harbor, on the contrary, she must enter so slowly as to permit her being brought to a stop within 200 or 300 yards to avoid collision. While running at this slow speed the vessel may have to contend with a strong cross-current containing floating ice, rendering the entrance very difficult, which difficulty would be greatly increased if at the same time a strong easterly wind were blowing.

The Oswego Harbor, with an entrance 350 feet wide, and a bad cross-current at times, is a somewhat similar case to this, and vessels are obliged to keep up full speed in order to make that entrance.

In the plan of ice-harbor used at Marcus Hook there is a clear space of 100 feet between adjacent piers, allowing a vessel to choose between several entrances, and to enter and leave the harbor against the current, so that the vessel is manageable at slow speed, and this advantage should be retained unless at the sacrifice of something still more important. This plan has appeared to work well in the past, and I have been unable to get at facts that would justify the proposed change of plan.

As far as the details of the plan are concerned, I have only given them sufficient study to make me feel very doubtful as to the piers and barriers being strong enough to do the duty required of them. The screw piles at Lewes could not be forced into the hard bottom, where the water-jet could not be used. At the site at Liston's Point the hard bottom is from 20 to 60 feet below mean high water, and it does not seem to me that even the piers, as projected, much less the intermediate light barrier, would stand the shocks of vessels and ice to which they would be exposed.

The barrier, or railing, is an indispensable part of the proposed plan, the piers being too small to afford protection to vessels, as is done by the piers at the existing ice-harbors. If the barrier is abandoned the whole plan goes with it.

The expense of the construction at such a locality of masonry piers, as at Marcus Hook, would be very great, and it is probable that a cheaper pier of iron could be devised that would be a suitable substitute. But as the only directly useful portion of these piers is that from, say, two or three feet below low water upwards, the rest of the pier only serving as a means of connection with the river bottom, the question naturally rises whether the pier could not be economically replaced by a floating ponton heavily anchored. It seems to me that all needed protection from the ice can be obtained in this manner at much less cost than by piers of iron or masonry, considering the great depth to hard bottom.

If the present proposed plan is not adopted, I would propose to study out the details of a plan for utilizing pontons in the formation of an ice-harbor at Liston's Point.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

F 8.

CONSTRUCTION OF IRON PIER IN DELAWARE BAY, NEAR LEWES, DELAWARE.

No work has been done during the past fiscal year. The last appropriation was $13,000, made August 2, 1882, and was applied to the repair of the wooden superstructure, which was but partially completed.

The decay of timber in the superstructure of the pier is very rapid, and to make the pier of value, the superstructure must be maintained with unimpaired strength. Parts weakened by decay must be removed early in their deterioriation, and be replaced by sound material. This renders the life of the timber of short duration and consequently the cost of maintenance large.

The railroad having its terminus in the vicinity of the pier has revived the question of using the pier in connection with their traffic, a privilege granted by the act of July 15, 1870. The present wooden superstructure was designed several years ago and before the adoption of the present heavier weights of engines and rolling stock. These increased weights render the present plan of wooden superstructure entirely too light for the increased loads which would be brought upon the pier in its use by the railroad company.

To add to the quantity of perishable material in a wooden superstructure would be only to increase largely the cost of its maintenance.

The plan as described in the project appended hereto proposes an iron superstructure with paved surfaces outside of the areas occupied by the railroad tracks upon the pier-head, and an iron superstructure carrying the track upon the approach to the pier-head, combined with the use of timber for the deck-covering over that part of the area of the approach not occupied by the railroad tracks. Such an iron superstructure, with a strength fully equal to the requirements of railroad traffic, could be built for about $93,000, and maintained at a trifling cost for repairs, rendering available the permanent iron substructure, which has been built at a cost of over $300,000.

A wooden superstructure, giving the same strength when new as the proposed iron superstructure, would cost at first probably $40,000, and would practically have to be entirely removed each ten years, so that its aggregate cost would in the end exceed that of an iron superstructure. Even with the above expenditure for repairs, the wooden superstructure would frequently be in a condition of impaired strength.

Should the project for the iron superstructure, which is appended hereto, be approved, an appropriation of the entire amount, namely, $93,000, is recommended for the fiscal year ending June 30, 1888, as when the change of superstructure is begun the pier will be useless until the new superstructure is completed.

The pier is in the collection district of Delaware, the nearest port of entry being Wilmington, where the amount of revenue collected during the year ending December 31, 1885, was $12,573.93. The nearest fort and light-house are, respectively, Fort Delaware and the Delaware Breakwater Light.

Total appropriations to June 30, 1886	$368,500 00
Total expenditures to June 30, 1886	368,312 86

Money statement.

July 1, 1885, amount available	$887 28
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	700 14
July 1, 1886, amount available	187 14
Amount (estimated) required for completion of existing project	15,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	15,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

SPECIAL REPORT OF LIEUTENANT-COLONEL HENRY M. ROBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., April 2, 1886.

SIR: I have the honor to submit the following report, in compliance with your indorsement on a copy of the resolution of the Senate of the United States, as follows:

> IN THE SENATE OF THE UNITED STATES,
> *March* 12, 1886.
>
> *Resolved*, That the Secretary of War be, and he is hereby, directed to cause an examination to be made of the "Government pier" on the Delaware Bay, near Lewes, in the county of Sussex and State of Delaware, with the view of ascertaining the probable cost of completing the superstructure thereof wholly of iron, so as to render the same available for the interchange of traffic and promotion of commerce, as contemplated by the act of Congress authorizing its construction; and that he furnish to the Senate, as early as practicable, an estimate of the cost [of] so completing the same.
>
> Attest:
>
> ANSON G. MCCOOK,
> *Secretary*.

The act of July 15, 1870, authorizing the construction of the Lewes Pier, in section 12 provides for "a good and substantial pier of stone or iron," and in section 13 makes it lawful for the "Junction and Breakwater Railroad, in the State of Delaware, to extend their railroad over and upon said pier, and freely to use said pier in connection with their said road, subject to such regulations and charges for maintenance and repairs as the Secretary of War may adopt."

The object of the resolution, then, is to ascertain the cost of completing the pier with an iron superstructure sufficiently strong for railroad traffic.

The present pier substructure consists of iron screw piles, arranged as follows:

From the shore line outward for a distance of 1,155 feet the substructure is 21 feet wide; the piles arranged in bents of three piles, 10½ feet between centers, on lines transverse to the axis of the pier; the bents are 21 feet apart. Beyond this narrow part the pier increases to a width of 42 feet for a further distance of 546 feet, making a total length of pier of 1,701 feet. The wide part is known as the "pier-head," and in it the piles are placed on transverse and longitudinal lines the same distance apart as in the narrow or shore arm of the pier.

In the plan proposed for the iron superstructure the shore-arm of the pier is arranged for a line of single track, the pier-head for a double track. The track on the shore-arm is carried by two built iron girders, resting upon rolled I beams, placed tranverse to the axis of the pier, and bearing upon the iron piles of the substructure. The deck of this part of the pier may be planked, or it may be paved with stone blocks, or asphaltum, supported by iron buckle-plates, as provided for in the estimates which follow.

The superstructure of the pier-head would consist of five longitudinal iron girders resting upon the pile-caps, giving support to transverse I beams, which, in turn, carry the longitudinal I beams supporting the tracks. The deck of the pier-head outside of the tracks would be paved with stone blocks or asphaltum, supported by buckle-plates resting upon the longitudinal girders and the transverse I beams. The superstructure of the pier-head should be sufficiently strong to bear the severest strain that will be imposed on it, which would be when both tracks are covered with the heaviest loaded box-cars, say 35 tons each, and the rest of the pier-head loaded with freight to the extent of 400 pounds per square foot. The piles have been tested to this extent without moving, and the estimates herewith are based on a construction to carry this strain with a coefficient of safety of from 4 to 5.

The following estimates are based upon present prices, with sufficient allowance for the probable fluctuations of one season. They do not include the cost of railroad ties and rails, which, as I understand the act authorizing the construction of the pier, are not to be put down by the Government:

ESTIMATES.

Cost of superstructure for single track on 1,155 linear feet of pier, and for double track on pier-head 546 feet long, areas outside of tracks to be paved with stone blocks or asphaltum resting on iron buckle-plates.

1,800,000 pounds iron (girders, I beams, and buckle-plates), at 5 cents per pound	$90,000
3,200 square yards paving, at $3 per square yard	9,600
Contingencies	15,400
Total	115 000

If the paving, together with the necessary iron work to support the same, is omitted from the 1,155 linear feet of pier leading to the pier-head, and is replaced by a wooden decking, the estimate would be as follows:

1,500,000 pounds iron (girders, I beams, and buckle-plates), at 5 cents per pound	$75,000
1,200 square yards paving on pier-head, at $3 per square yard	3,600
75,000 feet, B. M., pine timber for roadway decking on approach to pier-head, at $40 per 1,000 feet, B. M	3,000
Contingencies	11,400
Total	93,000

The water is so shallow that no vessels would be unloaded along the narrow portion of the pier comprising the approach to the pier-head, and the roadway on this part of the pier would have very light use and bear no heavier weight than occasional teams, so that it is probable that the last plan would answer every purpose of commerce at a diminished cost. Should it ever become advisable to make a stone or asphalt roadway on the approach to the pier-head it could be done at any time.

When the work is commenced the pier will be useless until it is entirely completed, so that it is of great importance that the entire amount should be appropriated at one time.

Very respectfully, your obedient servant,

HENRY M. ROBERT,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

F 9.

IMPROVEMENT OF HARBOR AT DELAWARE BREAKWATER, DELAWARE.

The last appropriation for this work was $75,000, made by the act of July 5, 1884.

During the past fiscal year the work in progress has been the closing of the gap, in accordance with the present project, between the breakwater and the ice-breaker. In the previous work done under this project, a mattress sill 90 feet wide and 2 feet thick had been placed along the axis of the gap and covered with stone.

Under the contract with Messrs. Andrews and Locke, dated December 16, 1884, 20,277 tons of stone were placed in the gap during the fiscal year. This contract was completed January 2, 1886, by the total delivery of 23,277 tons of stone.

On January 20, 1886, proposals were invited for about 10,000 tons of stone and a contract therefor entered into under date of March 4, 1886, with William M. Field, at the rate of $2.24 per gross ton.

Under this contract 10,062 tons were delivered, completing the contract on June 9, 1886, and making a total of 30,339 tons delivered in the gap during the past fiscal year under these two contracts. This work practically exhausted the funds available from the appropriation of $75,000 made July 5, 1884.

A recent study of the present sections of the breakwater and ice-breaker gives the following results: On the ice-breaker the mean slope on the harbor side is 1 vertical upon 1.3 horizontal, and on the outer slope 1 vertical on 2 horizontal. The breakwater, which is more directly subjected to wave-action and upon which the sea slope was possibly placed flatter than in the case of the ice-breaker, has upon the harbor face a mean slope of 1 vertical upon 1 horizontal, and on the sea face a slope of 1 vertical upon 2.2 horizontal above mean low water, and 1 vertical to 2.8 horizontal from mean low-water plane to the bottom.

The mean cross-section of the ice-breaker has a width on top of 22 feet and on bottom of 156 feet, with a height of 40 feet, giving a mean cross-sectional area of about 396 square yards.

The mean cross-section of the breakwater has a width of 22 feet on top and 176 feet on bottom, with a height of 42 feet, giving a mean cross-section of about 456 square yards.

The calculated volumes of the works, including voids, are as follows:

	Cubic yards.
Ice-breaker, including ends	190,000
Breakwater, including ends	405,000
Total	595,000

The quantity of stone placed in the work was 892,528 gross tons, or about 441,000 cubic yards of solid measurement.

The importance of this work to both the commerce of the Delaware River and the Atlantic coast is such as to justify sufficient appropriations to complete the breakwater by closing the gap at the earliest date possible.

The reports of the Maritime Exchange state that during the year 1885 1,701 vessels, exclusive of tugs, fishing and small coasting craft, anchored under the protection of the breakwater. This number is very much smaller than that stated in the annual reports for previous years. The practice of the past seems to have been for the keeper of the breakwater light to count each morning the vessels lying at anchor and to report the same as the number of vessels seeking the protection of the breakwater. By this method a vessel remaining at the breakwater several days awaiting orders, or through stress of weather, was counted repeatedly. The method adopted by the Maritime Exchange counts each vessel but once, regardless of the length of stay at the breakwater. This difference in the methods of reporting the number of vessels seeking the breakwater for protection, and the omission of tugs, fishing and small coasting craft which were formerly reported, will count for the difference between the past and present reports.

It is recommended that an appropriation of $300,000 be made for continuing the work.

This work is situated in the collection district of Delaware. Wilmington is the nearest port of entry, at which the revenue collected during the year ending December 31, 1885, was $12,573.93. Fort Delaware is the nearest fort, and the Breakwater Light the nearest light-house.

Total appropriations to June 30, 1886	$2,492,103 70
Total expenditures to June 30, 1886	2,490,524 37
Total appropriations under present project to June 30, 1886	200,000 00
Total expenditures under present project to June 30, 1886	198,420 67

Money statement.

July 1, 1885, amount available	$67,937 78
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	66,358 45
July 1, 1886, amount available	1,579 33
Amount appropriated by act approved August 5, 1886	56,250 00
Amount available for fiscal year ending June 30, 1887	57,829 33
Amount (estimated) required for completion of existing project	418,750 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	300,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for furnishing and placing stone in the gap at the Delaware Breakwater, received and opened February 19, 1886, *by Lieut. Col. Henry M. Robert, Corps of Engineers.*

No.	Names and addresses of bidders.	Price per ton.	Remarks.
1	John Satterlee, Englewood, N. J	$2 49	No statement of quarries or vessels.
2	John A. Bouker, New York City	2 19	Quality of stone unsatisfactory.
3	Samuel R. Cuming, New York City	2 44½	
4	Henry Opperman, jr., Harrisburg, Pa	4 89	
5	Cal I. Leiper, Chester, Pa., and George M. Lewis, Media, Pa	3 25	
6	James M. Andrews and George Willett Andrews, Biddeford, Me	2 24 2 35	For Delaware River stone. For Maine or Massachusetts granite.
7	William M. Field, Kentmere, Del	2 24	Recommended for acceptance.

Contract (dated March 4, 1886) awarded to William M. Field.

COMMERCIAL STATISTICS.

Statement showing number of vessels calling at the breakwater for harbor and for orders during the year ending December 31, 1885.

Description.	For harbor.	For orders.
Steamers	211	59
Ships	150	25
Barks	828	172
Brigs	194	55
Schooners	318	87
Total	1,701	398

The above information was furnished by the Philadelphia Maritime Exchange.

F 10.

IMPROVEMENT OF RANCOCAS RIVER, NEW JERSEY.

During the past fiscal year no work has been done on this river. The last appropriation ($10,000) was made August 2, 1882, and available funds were practically exhausted during the fiscal year ending June 30, 1883. Twenty thousand dollars have been appropriated for the improvement of this river, and have been applied to the formation of a channel about 100 feet wide and 6 feet deep at mean low water through Coate's Bar, which is about 4 miles above the river mouth, and to the construction of a regulating dike from the north bank of the river to the upper end of Hamill's Island.

No operations are contemplated during the present season, as no funds are available.

In furtherance of the approved project, a channel with a low-water depth of 6 feet, should be dredged through the shoals between Coate's Bar and Centreton at a cost which has been estimated at $22,000. This amount could be profitably expended during the fiscal year ending June 30, 1888.

Rancocas River is in the collection district of Trenton, N. J., which is the nearest port of entry, at which no revenue was collected during the year ending December

31, 1885. The nearest fort is Fort Mifflin, and the Horseshoe range lights are the nearest light-houses.

Total appropriations to June 30, 1886	$20,000 00
Total expenditures to June 30, 1886	19,899 91

Money statement.

July 1, 1885, amount available	166 76
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	66 67
July 1, 1886, amount available	100 09
Amount (estimated) required for completion of existing project	62,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	22,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels during the year ending December 31, 1885.

Description.	Arrivals.			Departures.		
	Number.	* Tonnage.	Crews.	Number.	* Tonnage.	Crews.
Steamers (not including tugs)	360	48,600	1,570	360	54,000	1,570
Sailing vessels	1,350	65,000	4,080	1,350	83,000	4,080
Barges	730	45,400	1,300	730	142,000	1,300
Canal-boats	1,380	47,000	1,460	1,380	87,000	1,460
Totals	3,820	206,000	8,410	3,820	366,000	8,410

* The tonnage is of the cargoes and not of the vessels.

Exports and imports.

Articles.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
Brimstone .... tons			800	$18,400
Cement and plaster .... barrels			2,000	4,000
Coal .... tons			8,500	34,000
Lumber and timber .... feet			3,500,000	160,000
Laths and shingles			800,000	7,500
Lime .... bushels			98,000	37,000
Manure .... cart-loads			10,000	10,000
Pig-lead .... tons			5	400
Saltpeter and potash .... do			500	20,000
Salt .... do			100	1,000
Tin .... do			3	1,800
Tin .... boxes			2,000	10,000
Miscellaneous merchandise				100,000
Canned goods .... pounds	1,600,000	$40,000		
Fruit .... baskets	20,000	10,000		
Fertilizers .... tons	8,000	240,000		
Sand (molding) .... do	150,000	225,000		
Vegetables .... baskets	40,000	20,000		
Total		535,000		404,100

The above information was furnished by Messrs. J. L. Anderson & Sons, of Mount Holly, N. J., and Messrs. J. J. Allen's Sons, of Philadelphia, Pa.

F 11.

IMPROVEMENT OF WOODBURY CREEK, NEW JERSEY.

No work of improvement has yet been done on this creek. The only appropriation made therefor was $5,000, on August 2, 1882. With the exception of $450.31, expended in 1882 for a survey of the creek, this amount is yet available. The proposed plan of improvement was the formation, by dredging, of a temporary channel 8 feet deep at high water and 40 feet wide, between the mouth of the creek and the village of Woodbury, a distance of about 4 miles, at an estimated cost of $15,000. From the impossibility of the permanence of a dredged channel the improvement would be of little value unless provision is made for its maintenance. While citizens directly interested have expressed themselves as willing to contribute a reasonable sum towards the maintenance of the channel, there is no guarantee that a channel once formed by the United States would be maintained by private effort. Since the formation of a dredged channel to any point short of Woodbury would be of no commercial value, and since any channel formed would not be permanent, the expenditure of available funds should be withheld, if the improvement is to be made, until the funds available will permit the formation of the proposed channel in a single season. The additional sum of $10,500 could be profitably expended during the fiscal year ending June 30, 1888.

This work is in the collection district of Philadelphia, Pa., which is also the nearest port of entry, at which the revenue collected during the year ending December 31, 1885, was $13,801,190.61.

Fort Mifflin is the nearest fort, and the Schuylkill range lights are the nearest light-houses.

Total appropriations to June 30, 1886	$5,000 00
Total expenditures to June 30, 1886	450 31

Money statement.

July 1, 1885, amount available	$4,549 69
July 1, 1886, amount available	4,549 69
Amount (estimated) required for completion of existing project	10,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,500 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels during the year ending December 31, 1885.

Sailing vessels	40
Barges	108
Total	148

Exports and imports.

Articles.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
Bricks			200,000	$2,000
Coal, tons			12,500	50,000
Clay, sand and stone, do			6,600	10,000
Cement, lime, and plaster, barrels			10,150	6,450
Fertilizers and manure, tons			8,000	25,000
Hay, do			600	6,000
Lumber, feet			5,000,000	60,000
Laths and shingles, do				5,000
Soda ash, tons			1,500	45,000
Wood, cords			1,500	4,500
Fruit and vegetables		$4,000		
Glass, tons	7,000	500,000		
Miscellaneous merchandise		20,000		
Totals		524,000		213,950

The above information was furnished by Mr. C. W. Starr, of Woodbury, N. J.

F 12.

IMPROVEMENT OF MANTUA CREEK, NEW JERSEY.

No work of improvement has yet been done on this creek. The only appropriation made therefor was $3,000 on August 2, 1882, the expenditure of which was withheld by order of the Secretary of War until further appropriation should be made. The stream in its natural condition has a low-water depth of about 9 feet for a distance of between 3 and 4 miles from its mouth. Above this the channel depth slowly decreases until, at Mantua, about 11 miles above the mouth, there is a low-water depth of only 2 feet. The opinion of officers previously in charge was that there seems to be no necessity at present for further appropriations, and none are recommended.

This work is in the collection district of Philadelphia, Pa., which is also the nearest port of entry, at which the revenue collected during the year ending December 31, 1885, was $13,801,190.61. Fort Mifflin is the nearest fort, and Tinicum and Fort Mifflin Bar Cut range lights are the nearest light-houses.

Total appropriations to June 30, 1886, $3,000.

Money statement.

July 1, 1885, amount available	$3,000 00
July 1, 1886, amount available	3,000 00
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	32,000 00

F 13.

IMPROVEMENT OF RACCOON RIVER, NEW JERSEY.

No work of improvement has yet been done on this river. The only appropriation made therefor was $3,000 on August 2, 1882. With the exception of a part expended in 1882 upon a survey of the river, this amount is yet available. The proposed plan of improvement was to make, by dredging, the navigation of the river safer and less difficult up to Swedesborough, at an estimated cost of about $18,000. By previous recommendation the appropriation of 1882 was withheld from expenditure until additional appropriations are made.

If the improvement is to be made, the sum of $16,000, in addition to what has already been appropriated, could be expended in dredging during the fiscal year ending June 30, 1888.

This work is in the collection district of Philadelphia, Pa., which is also a port of entry, at which the revenue collected during the year ending December 31, 1885, was $13,801,190.61.

Fort Mifflin is the nearest fort, and the Tinicum Island and Fort Mifflin Bar range lights the nearest light-houses.

Total appropriations to June 30, 1886	$3,000 00
Total expenditures to June 30, 1886	757 23

Money statement.

July 1, 1885, amount available	$2,242 77
July 1, 1886, amount available	2,242 77
Amount (estimated) required for completion of existing project	16,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	16,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Arrivals and departures of vessels during the year ending December 31, 1885.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steamers	4	928	4	928
Sailing vessels	16	1,920	16	1,920
Barges	8	1,200	8	1,200
Canal-boats	10	900	10	900
Total	38	4,948	38	4,948

Exports and imports.

Articles.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
Lumber ... feet			300,000	$4,500
Coal ... tons			3,000	15,000
Stone ... do			550	960
Lime ... bushels			8,000	850
Bricks			100,000	1,200
Oyster-shells ... bushels			20,000	600
Manure ... cart loads			40,000	24,000
Flour and grain ... barrels			350	1,000
Fruit and vegetables ... do		$88,000		
Total		88,000		48,110

The above information was furnished by Mr. John Ford, of Swedesborough, N. J.

F 14.

IMPROVEMENT OF SALEM RIVER, NEW JERSEY.

No work has been done on Salem River during the past fiscal year, and no appropriation for its improvement has been made since that of August 2, 1882, of $1,500. The expenditure of this appropriation was withheld on account of the smallness of the sum and the exorbitant price bid for the dredging, which was 78 cents per cubic yard.

As stated in the Annual Report of the Chief of Engineers for 1882, page 814:

> At the point where the creek most nearly approached the Delaware River, in the vicinity of Deep Water Point, a canal was opened in 1872 for the better drainage of the meadows bordering the upper part of the creek and to secure a more direct water outlet for the products of that region. In furtherance of this design a dam was also built across the creek below the canal, thus separating the stream into two independent water-courses, one having its head at the dam and discharging past Salem into the cove, the other with its head of navigation at Course's Landing, 3 miles below Sharptown and 9 miles from the Delaware, into which it discharges via the canal, which forms the lower 2 miles of its length. The mouths of the two streams are now, therefore, about 10 miles apart, and the drainage of each is entirely distinct.

The canal has, to a great extent, failed to accomplish its purpose by reason of its originally insufficient capacity, whereby the tidal rise, which is about 6 feet in the Delaware, is reduced to about 1 foot at the confluence of the canal and creek.

The natural mouth of the stream is obstructed by extensive sandbars, to which dredging would afford but temporary relief, unless supplemented by quite expensive dike construction, extending across these shoals and into the Delaware River, while the bed of the upper part of the river is obstructed with shoals or reduced, from lack of tidal flow, to the dimensions of a meadow brook.

It would seem that the comprehensive improvement of Salem River might be deferred until the commerce of the vicinity should render its improvement more urgent than it seems to be at present. Should Congress consider it desirable to continue the improvement, the deepened channel on the upper river might be completed to Hoxie's Landing, which has been estimated to cost $4,000.

Salem River is in the collection district of Bridgeton, N. J., which is the nearest port of entry, at which no revenue was collected during the year ending December 31, 1885. The nearest fort and light-houses are, respectively, Fort Delaware and Finn's Point range lights.

Total appropriations to June 30, 1886	$14,500 00
Total expenditures to June 30, 1886	13,009 34

Money statement.

July 1, 1885, amount available	$1,490 66
July 1, 1886, amount available	1,490 66

COMMERCIAL STATISTICS.

Arrivals and departures of vessels during the year ending December 31, 1885.

Description.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Steamers	3	600	3	600
Sailing vessels	12	1,200	12	1,200
Barges	20	2,000	20	2,000
Canal-boats	8	800	8	800
Total	43	4,600	43	4,600

Exports.

Articles.		Quantity.	Value.
Lumber	feet	1,000,000	$200,000
Grain	bushels	100,000	50,000
Coal	tons	5,000	25,000
Lime	bushels	1,000,000	100,000
Canned fruits	cans	500,000	100,000
Fruit	baskets	100,000	50,000
Vegetables	do	3,500,000	350,000
Agricultural implements			50,000
Miscellaneous merchandise			100,000
Total			1,025,000

The above information was furnished by Dr. Charles Newton, of Sharptown, N. J.

F 15.

IMPROVEMENT OF COHANSEY CREEK, NEW JERSEY.

No work has been done on Cohansey Creek during the past fiscal year, and no appropriation for its improvement has been made since that of August 2, 1882, appropriating $5,000. This amount was practically expended during the fiscal year ending June 30, 1883, in widening and deepening the channel below Broad Street Bridge at Bridgeton to a depth of 7 feet at mean low water.

At Bridgeton the creek is obstructed by the crossing of the gas and water mains, which are placed at a depth of about 4 feet below mean low water. The attention of the city authorities has been officially called to the matter, and they have had the question of lowering these pipes under consideration for several years, but no action thereon has yet been taken. The improvement of the creek above this point would be without value until the pipes are lowered to a proper depth by the municipal authorities of Bridgeton, and until this is done no appropriation is recommended.

This work is in the collection district of Bridgeton, N. J., which is the nearest port of entry, at which no revenue was collected during the year ending December 31, 1885. The nearest fort and light-house are, respectively, Fort Delaware and Maurice River Light.

Total amount appropriated to June 30, 1886	$36,000
Total amount expended to June 30, 1886	36,000

Money statement.

Amount (estimated) required for completion of existing project Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	$5,500

F 16.

REMOVAL OF WRECKS FROM DELAWARE BAY AND RIVER.

There have been no operations during the past fiscal year under this appropriation, the removal of all wrecks having been accomplished under the general provisions for "removing sunken vessels or craft obstructing or endangering navigation."

Money statement.

July 1, 1885, amount available	$2,420 97
July 1, 1886, amount available	2,420 97

F 17.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

During the past fiscal year there have been removed from the Delaware River under the provisions of section 4, act of June 14, 1880, the wrecks of the sloop Ann and the steam canal-boat Thomas Carroll.

The sloop Ann, a wooden vessel of about 51 tons measurement, was sunk in July, 1883, in 4 fathoms of water, about 600 feet west of Deep Water Point Range and off the lower part of New Castle, Del. The vessel was a dangerous obstruction to navigation.

The steam canal-boat Thomas Carroll, a wooden vessel of about 151 tons, was sunk in October, 1884, in about 4 fathoms of water, near the intersection of the Schooner Ledge and Cherry Island Flats ranges. An examination showed about 21 feet of water over the highest part of the wreck.

These vessels having been abandoned by their owners, proposals for their removal were received under date of September 4, 1885, and the contract therefor was awarded to Frank C. Somers, the lowest bidder, for the sum of $800 for both wrecks. The work was accomplished on September 25, 1885.

An examination was made of parts of the wreck of the ship Adolphus, lying in the path of vessels and about 4 miles east of Cape Henlopen. The wreck was considered as endangering navigation. The necessary notice to owners has been given and proposals for its removal invited.

Abstract of proposals for removal of wrecks in the Delaware River, received and opened September 4, 1885, by Lieut. Col. Henry M. Robert, Corps of Engineers.

No.	Names and addresses of bidders.	Price for removing—		
		Sloop Ann.	Steam canal-boat Thomas Carroll.	Both wrecks.
*1	H. S. Wright, Philadelphia, Pa	$425	$500	....
2	Charles W. Johnston, Lewes, Del	445	540	$985
*3	Baltimore Wrecking Company, Baltimore, Md	450	500	959
4	William E. Chapman, New York City	800	1,400	1,784
5	Atlantic and Gulf Wrecking Company, Somers Point, N. J.	400	700	1,000
6	Hibbard Youngs, Brooklyn, N. Y	977	1,333	2,310
7	American Dredging Company, Philadelphia, Pa	500	900	1,100
8	Frank C. Somers, Philadelphia, Pa	....	....	800
9	Elijah D. Register, Lewes, Del	394	1,189	1,583

*Informal.

NOTE.—On September 5, an informal proposal was received by mail from Mr. John W. Guider, of New York City, for removing the Ann at $2,000 and Carroll at $12,000; both wrecks, $14,000.

Contract (dated September 11, 1885) awarded to Frank C. Somers.

F 18.

UNITED STATES COMMISSION ADVISORY TO THE BOARD OF HARBOR COMMISSIONERS OF PHILADELPHIA, PENNSYLVANIA.

During the fiscal year ending June 30, 1886, the *personnel* of the United States Commission Advisory to the Board of Harbor Commissioners of the port of Philadelphia has remained unchanged. It is constituted as follows:

Capt. G. B. White, United States Navy, chairman; Prof. Henry Mitchell, United States Coast Survey; and Lieut. Col. Henry M. Robert, United States Army, members, and Mr. H. L. Marindin, United States Coast Survey, secretary.

There has been a number of meetings of the commission during the year and much valuable work has been done and important conclusions reached. As the result of careful study and investigation, on February 13, 1886, the commission submitted to the Board of Harbor Commissioners plans for a port-warden's line on the Delaware River front, which practically fixed that line from the mouth of the Schuylkill to Bridesburg. A description of said line and a copy of a letter transmitting the same to the Harbor Commissioners are appended hereto. This line was approved by the Harbor Commissioners and formally adopted by the councils of the city of Philadelphia, and is now, therefore, definitely established as the legal port-warden's line for this part of the Delaware River front, which cannot be changed except by State legislation.

When the question of a port-warden's line from Bridesburg to the upper limits of the city came under consideration of the commission, it was found that while there was a good hydrographic chart, recently finished by the Engineer officer in charge of the Delaware River improvements, no physical survey of this part of the river had ever been made. The commission was of the opinion that it could not intelligently act upon the very important question before it without the data that would be furnished by such physical survey. The views of the commission upon this subject are fully set forth in the memorandum furnished to the Board of Harbor Commissioners, a copy of which is hereto appended.

The councils of the city of Philadelphia, upon the request of the Harbor Commissioners, appropriated the sum of $2,500 for the purpose of making this survey, and the work is being done by the United States Coast Survey, at the expense of the city, and under the immediate direction of Mr. H. L. Marindin, secretary of the commission. The field work is nearly finished, and it is expected that the commission will be in possession of a good physical chart of this part of Delaware River early this fall.

Pending the establishment of a definite port-warden's line for this upper part of the river, the commission, at the request of the Harbor Commissioners, prepared a chart upon which was drawn a line beyond which, in its opinion, no wharf should be allowed to extend. The city councils have passed a resolution requesting the board of port wardens not to grant permission to build beyond this line pending the establishment of a definite line. This action will doubtless preserve the river from encroachment.

The following work for the commission yet remains, and when it is done the purpose for which it was created will have been accomplished, viz:

To refer the Delaware River line to fixed monuments, and to prepare plans for a port-warden's line around Smith's and Windmill islands, and from the mouth of the Schuylkill to the lower limits of the city.

It is believed that the whole work will be completed by the close of the next fiscal year.

LETTER TO THE BOARD OF HARBOR COMMISSIONERS.

PHILADELPHIA, PA., *February* 13, 1886.

SIR: Herewith we have the honor to transmit to the Harbor Commission of Philadelphia three charts and a description of a port-warden line of the Delaware River Front for the portion from the mouth of the Schuylkill River to a point opposite Bridge street, at Bridesburg.

In deciding to recommend this line, we need hardly state that it is not such as we should have drawn had we found the river in its original condition, and had been required to provide for the retention of its natural facilities for navigation. Our physical survey discovered that the river has adjusted itself to the encroachments from its shores; sometimes to the injury, sometimes to the advantage of navigation, and that, in the main, these effects have ultimated so that the introduction of large changes in the alignment of the piers at this late hour would involve uncertain consequences in localities where great commercial establishments exist, without the certainty of improvement elsewhere. It has therefore been the study of your Advisory Board to make only such changes as should be necessary to preserve the net advantage to the community.

It will be observed that the line we recommend cuts off a considerable portion of the wharf of the Pennsylvania Railroad at Greenwich Point, and a small part of pier 69 below Tasker Street, and it is suggested that the city should treat with these parties for the removal of the protruding portions of these structures, at least whenever extensive repairs shall become necessary.

The line along the coal wharves above Greenwich Point has been located so as not to interfere with existing structures, in the confident anticipation of the removal of the middle ground, which seriously obstructs navigation in this neighborhood.

The portion of the line above Richmond has been located with due reference to the works of channel improvement undertaken by the General Government above Petty's Island. This improvement, while it does not conform in plan and disposition of works to that suggested in 1883 by your Advisory Board, promises to lead in the same direction and inspires much hope of success.

The port-warden line for the frontage above Bridesburg and for the islands will be recommended as soon as the necessary surveys and studies are complete, and then a general report will be submitted, in which the surveys, observations, and computations will be furnished in detail.

The description which is herewith inclosed fixes geodetically all the turning points and gives the direction and distance from point to point. It is proposed by this Board to refer this port-warden line to monuments to be planted at designated points, so as to render its location more convenient for practical purposes. Some of these monuments are now in position, and as soon as the season will permit the work will be pushed to completion, and we request authority to file a further description of this same line at some date in the near future.

In conclusion, this Board desires to state that the delay in reporting a revised port-warden line is attributable to the following causes: The desire to secure the joint action of the States of New Jersey and Pennsylvania, the discovery that legislation by the State authorities was necessary, and, so far as the upper part of the line is concerned, the completion of the survey.

G. B. WHITE,
Captain, U. S. N., Chairman.
HENRY MITCHELL,
Coast and Geodetic Survey.
HENRY M. ROBERT,
Lieut. Col. Engineers, U. S. A.

The PRESIDENT OF THE HARBOR COMMISSION
For the Port of Philadelphia.

DESCRIPTION OF PORT-WARDEN LINES FOR THE DELAWARE RIVER BETWEEN THE MOUTH OF THE SCHUYLKILL RIVER AND BRIDESBURG.

[Prepared by the United States Advisory Commission, Commander George B. White, U. S. N., chairman, November, 1884, adopted by the Philadelphia Harbor Commissioners and confirmed by the councils of the city of Philadelphia.]

Beginning at the point A, shown on the accompanying tracing sheet No. 1 (which point coincides with the terminal point of the port-warden's line for the left bank of the Schuylkill River, as shown on the official copy presented to the Board of Harbor Commissioners of Philadelphia, June, 1882), the line runs N. 80° 36′ 39″ E. 4138.8 feet to B in lat. 39° 53′ 07.846″, long. 75° 10′ 35.227″; thence by a straight line N. 88° 21′ 24″ E. 3134.7 feet to C in lat. 39° 53′ 08.736″, long. 75° 09′ 55.021″; thence by a straight line E. 8° 52′ 25″ S. 1926.98 feet to D in lat. 39° 53′ 05.797″, long. 75° 09′ 30.597″; thence by a straight line E. 4° 39′ 13″ S. 1148.46 feet to E in lat. 39° 53′ 04.878″, long. 75° 09′ 15.909″; thence by a straight line N. 79° 58′ 28″ E. 1108.15 feet to F in lat. 39° 53′ 06.784″, long. 75° 09′ 01.910″; thence by a straight line N. 64° 22′ 07″ E. 558.22 feet to G in lat. 39° 53′ 09.171″, long. 75° 08′ 55.451″; thence by a straight line N. 54° 02′ 27″ E. 689.47 feet to H in lat. 39° 53′ 13.171″, long. 75° 08′ 48.290″; thence by a straight line N. 46° 27′ 55″ E. 1161.27 feet to I in lat. 39° 53′ 21.080″, long. 75° 08′ 37.492″; thence by a straight line N. 40° 46′ 54″ E. 1084.95 feet to K in lat. 39° 53′ 29.201″, long. 75° 08′ 28.393″; thence by a straight line N. 35° 16′ 48″ E. 677.35 feet to L in lat. 39° 53′ 36.278″, long. 75° 08′ 21.898″; thence by a straight line N 29° 48′ 43″ E. 1114.00 feet to M in lat. 39° 53′ 45.831″, long. 75°08′ 14.795″; thence by a straight line N. 21° 41′ 12″ E. 1399.25 feet to N. in lat. 39° 53′ 58.684″, long. 75° 08′ 08.160″.

The next line is shown on tracing sheet No. 2.

Beginning at N. the line runs by a straight line N. 18° 09′ 22″ E. 2152.1 feet to O in lat. 39° 54′ 18.895″, long. 75° 07′ 59.551″; thence by a straight line N. 9° 34′ 35″ E. 974.23 feet to P in lat, 39° 54′ 28.392″, long. 75° 07′ 57.471″; thence by a straight line N. 2° 32′ 11″ W. 1238.1 feet to Q in lat. 39° 54′ 40.616″, long. 75° 07′ 58.176″; thence by a straight line N. 10° 52′ 35″ W. 1003.3 feet to R, in lat. 39° 54′ 50.356″, long. 75° 08′ 00.606″; thence by a straight line N. 17° 18′ 59″ W. 1009.7 feet to S in lat. 39° 54′ 59.855″ long. 75° 08′ 04.463″; thence by a straight line N. 21° 27′ 34″ W. to the point T, which lies at the intersection of the prolongation of the north side of Tasker street with the southerly extension of the present authorized port-warden line of 1856, from its turning point off the foot of Christian street to the point on the extension of the north side of Dickinson street, 560 feet from the west side of Delaware avenue. Thence along the extended authorized port-warden line of 1856 to the point T′, which coincides with the turning point on the port-warden line of 1856, 560 feet from the west side of Delaware avenue, on the extension of the north side of Dickinson street.

From the point T′, off the foot of Dickinson street, to the turning point at the foot of Ann street, in Petty's Island, north channel, no changes in the present authorized port-warden line of 1856 are proposed by this commission.

Beginning at the point U, shown on the accompanying tracing sheet No. 3 (which point lies on the southerly extension of the east side of Ann street, 963 feet 11½ inches from the south side of Delaware avenue, and is one of the turning points of the present authorized port-warden line of 1856), the line runs by a straight line N. 72° 3′ 24″ E. to V in lat. 39° 58′ 41.978″, long. 75° 05′ 17.700″; thence by a straight line N. 70° 12′ 23″ E. 1702 3 feet to W. in lat. 39° 58′ 47.674″, long. 75° 04′ 57.122″; thence by a straight line N. 63° 43′ 01″ E. 1550.0 feet to X in lat. 39° 58′ 54.463″, long. 75° 04′ 39.269″; thence by a straight line N. 53° 09′ 02″ E. 1099.6 feet to Y in lat. 39° 59′ [illegible], long. 75° 04′ 27.965″; thence by a straight line N. 50° 13′ 17″ E. 1165.0 feet to Z. in lat. 39° 59′ 08.347″, long. 75° 04′ 16.466″; thence by a straight line N. 43° [illegible] 22″ E. 814.44 feet to A′ in lat. 39° 59′ 14.145″, long. 75° 04′ 09.216″; thence by a straight line N. 37° 51′ 10″ E. 814.83 feet to B′ in lat. 39° 59′ 20.506″, long. 75° 04′ 02.781″; thence by a straight line N. 29° 30′ 10″ E. 790.12 feet to C′ in lat. 39° 59′ 27.301″, long. 75° 03′ 57.775″; thence by a straight line N. 20° 51′ 01″ E. 3493.5 feet to D′, in lat. 39° 59′ 59.573″, long. 75° 03′ 41.804″, which point lies off the wharf at the foot of Bridge street, in Bridesburg.

All the bearings given above are true, and the geographical positions refer to the data of the Coast Survey triangulation of 1877, which gave for the position of Girard College triangulation point lat. 39° 58′ 24.07″, long 75° 10′ 14.81″.

ON THE NECESSITY FOR A PHYSICAL SURVEY IN THE PROPER LOCATING OF PORT-WARDEN LINES.

There have been several surveys of the harbor of Philadelphia, and those of 1819 1843, and 1878 we have regarded as reliable. Comparisons among these reveal very large changes in the dimensions and locations of channels and shoals that have resulted from the artificial structures and encroachments along the shores. These comparisons also show that injuries to navigation were by no means necessary results of the utilization of the harbor, and that the beneficial effects fortuitously occurring here and there might have been foreordained and extended if a proper study had preceded the locations of port-warden's lines in former years.

The laying out of a highway on the land is a matter in regard to which the careless passer-by may form a somewhat intelligent opinion; but when it comes to the treatment of a natural water-course, even the careful and public-spirited may be misled by a too *superficial* view. We use the word *superficial* here in its rarely literal sense, for it is *space* only that strikes us in looking upon the natural harbor or its chart, the depth of the river and its passing volume being occult. A statement of this kind would seem too obvious to be made, but it is really one of those *too familiar* truisms that are overlooked.

The soundings and gaugings of the Advisory Commission have discovered that the best effects in the improvement of navigation have sometimes resulted from the occupation of water spaces which excited at the outset the indignation of a jealous public; while ill effects have often resulted from slight extensions elsewhere which the public ignored.

A physical survey is necessary to determine to what extent any proposed encroachment will interrupt or turn aside the stream, and it is by gauging the volume to be displaced on the ebb, on the flood, and in freshets that we measure in advance the *strain* upon the channel. For in alluvial bottoms the channel is the cast of the living waters within; it is not the independent mold into which the river is turned, but it is the trough hollowed out by the running water, and it alters its form and direction with every change that may be induced upon the flow.

Before giving license to encroachments, the consequences must be measured. It is a question between the individual interest and the interest of the community, and the privilege to use the public domain should involve no injury which is not more than counterbalanced by public good. As it is, the community has not made the best of the bargain in dealing with the individual, and the little loss of advantage has multiplied with the growth of trade till it is a heavy burden.

A wharf is a harbor improvement; it furnishes a better landing than naturally existed, so that trade is made possible, or more convenient and profitable; but if the wharf is so extended as to turn the stream somewhat from its natural course, so that it is lengthened or caused to attack the opposite shore, or create shoals, the advantage to the community is in question. Experience has shown that the occupation of a harbor for commercial purposes need not impair its natural advantages for navigation; the natural banks may be walled in, often to the improvement of navigation. So that granting of licenses to build wharves under proper restrictions or provisions is not parting with valuable privilege, but securing guarantees of improvement.

Before public roads were laid out the owner of a house could venture to encroach on the wagon-road where few had ever passed, and where his act would pass unresented; but when a busy city has sprung up about him his little act of cupidity has all the effect of a great crime, for it now obstructs or retards the commerce of the world. The public are quick to detect the smallest encroachment upon a city street; it cannot be concealed, and it must be immediately resented. But the greatest of all highways, the harbor channel leading to the sea, is out of sight and therefore usually out of mind. One would suppose that the community would have the main channel under perpetual survey, but in most cases the interest in the channel is spasmodic, and when the rare surveys are compared the injuries to the channel cannot be charged upon the individuals or upon special works along shore. So many causes and effects have accumulated in the long interval of indifference that they can no longer be distinguished.

The city front above Richmond has been but little utilized because of the great shoal that has accumulated in the neighborhood of Five Mile Point, and which the General Government now designs to remove in part. Should the Government be successful, the water front that the city offers above will be appreciated because of its bold banks and handy channel.

We have before us a map of this portion of the Delaware from Five Mile Point to the city limits at Poquessing Creek, executed in part by the city and in part by the General Government. The shore-lines and objects on the land are from surveys directed by the city engineer, while the soundings were mapped and made under the direction of the United States Engineers.

As we go up the Delaware from the bay the traces of tidal action lessen and the physical characteristics of river flowage relatively increase. Above Bridesburg there are regular "crossings" between reverse curves, and there are bars at these points of *inflection*, much the same as in tideless rivers, except that more water can be carried over them. It would seem that the tides are beneficial, since they prevent the completion of the obstructions at the nodes of the bends.

The reach of river between Bridesburg and Poquessing Creek (the city limit) is almost in a state of nature, but has great qualifications for commercial frontage. The main channel lies in great bends, crossing from side to side, but these bends are favorable to bold frontage. Were the river straight the channel would be midway between the two shores, and wharves of at least a thousand feet in length would be necessary to reach the border of the ship channel. As it is we find in the two bends continuous frontages of three-quarters of a mile each in which one may reach the 4-fathom line by wharves of only 200 or 300 feet in length. Between the two bends there is moreover a subsidiary channel crossing the convex, and giving a pretty good frontage where least expected ordinarily. This channel is a sort of *wasteway* or *cut-off*, and serves the still further purpose of shortening distance in the navigation of ordinary vessels. In short, the natural advantages of this whole frontage above Bridesburg are unusual, but, *for this reason, more likely to be impaired by utilization than improved.*

From near the head of Petty's Island 4-fathoms may be carried up the channel at low water to a point nearly abreast of Pennypack Creek, or about 5½ miles. Here is a "*crossing*" with not less than 3 fathoms upon it, and beyond the 4-fathom channel resumes and continues very nearly to the city limits.

With a view to the preservation of all these natural advantages of both channel-way and landing, we should accommodate all artificial structures on the foreshores to the flow of the water, so as to introduce no material change among the forces at work. These forces are ebb and flood tidal currents (during the greater portion of the year) and river currents of varying velocity and volume during the season of freshets. What we observe in the form of the channels and banks is really an *adjustment* in which features favorable to our wants are, in some sense, fortuitous, not usually present in so great degree.

It is proposed to gauge the currents and determine their *resultants* reflected in the *adjustment* to which we have just referred. At about 40 cross-sections we should determine the transverse curves of velocities, so as to learn in what manner the volume passes during the flood, during the ebb, and during the freshets; we then should draw in upon the chart lines of equal velocities for ebb and for flood (isodynamic lines), and ultimately lines of equal *resultant* power or *equal scour;* and when we came to the drawing of a port-warden line we should adjust it to these natural lines, so as to secure all that can be safely used; it should be the line between use and abuse.

Approved by the Board Advisory to the Philadelphia Harbor Commissioners, and forwarded to the Philadelphia Harbor Commissioners as the expression of the views of the Board on this subject.

G. B. WHITE,
Captain, U. S. Navy,
Chairman Board Advisory to Philadelphia Harbor Commissioners.

FEBRUARY 25, 1886.

APPENDIX G.

IMPROVEMENT OF HARBORS AND RIVERS IN THE STATES OF DELAWARE AND MARYLAND—IMPROVEMENT OF MAURICE RIVER, NEW JERSEY.

REPORT OF MR. WILLIAM F. SMITH, UNITED STATES AGENT, IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Maurice River, New Jersey.
2. Wilmington Harbor, Delaware.
3. Ice-harbor at New Castle, Delaware.
4. Duck Creek, Delaware.
5. Saint Jones River, Delaware.
6. Mispillion Creek, Delaware.
7. Broadkiln River, Delaware.
8. Broad Creek, Delaware, from its mouth to Laurel.
9. Indian River, Delaware.
10. Susquehanna River above and below Havre de Grace, Maryland.
11. Chester River at Kent Island Narrows, Maryland.
12. Chester River from Spry's Landing to Crumpton, Maryland.
13. Corsica Creek, Maryland.
14. Choptank River, Maryland.
15. Wicomico River, Maryland.
16. Upper Thoroughfare, between Deil's Island and the mainland, Maryland.

UNITED STATES ENGINEER OFFICE,
Wilmington, Del., July 29, 1886.

GENERAL: I have the honor to submit herewith the Annual Report of the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1885.

Very respectfully, your obedient servant,

WM. F. SMITH,
United States Agent.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

G 1.

IMPROVEMENT OF MAURICE RIVER, NEW JERSEY.

Under a contract with the American Dredging Company, of Philadelphia, operations during the fiscal year were confined to the 4 miles of the river below the town of Millville. Little had been done at the commencement of the year, as work was not begun until near the close of last fiscal year. The contract was completed in April, 1886, and the following improvement is the result of the work:

A channel was dredged through French's Bar, 4 miles below Millville, 200 feet in length, 100 feet wide; from a point 2.14 miles below Millville a channel was dredged 100 feet wide to a point called Pea Landing (including a cut through the point of land at Silver Run, the right of way having been given the United States free of cost); from Pea Landing to the bridge at Millville the channel was dredged 50 feet in width, except just below the bridge, where the width was increased to 75 feet for a distance of 300 feet. This increased width was to cut off a point. Above the bridge for a distance of 400 feet a channel was dredged 100 feet in width, and from this point to Wood's Mills, the head of navigation, a distance of 2,600 feet the channel was reduced again to 50 feet in width. A depth of from 5 to 6 feet was made over the entire dredged channel.

The excess in depth over what was required by the contract (4 feet) was necessary to float the contractor's plant, and was made at their expense. The total amount of material removed in accordance with the terms of the contract, is 110,015 cubic yards, measured in place, which exhausted the appropriation.

This improvement has been beneficial already to the commerce of this river, which is extensive, by enabling a larger class of vessels to reach Millville without interruption by low water.

It is proposed to apply the appropriation asked for the fiscal year ending June 30, 1888, to continuing the work of improvement for a 6-foot low-water navigation by dredging wherever a less depth of water is found in the river.

This work is in the collection district of Bridgeton, N. J., which is also the nearest port of entry, and at which no revenue was collected during this fiscal year.

AMOUNTS APPROPRIATED.

By act passed August 2, 1882	$3,000
By act approved July 5, 1884	17,000
Total	20,000

Money statement.

July 1, 1885, amount available	$18,995 20
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	18,994 14
July 1, 1886, amount available	1 06
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,001 06

Amount (estimated) required for completion of existing project	87,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	35,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

LETTER OF COLLECTOR OF CUSTOMS AT BRIDGETON, NEW JERSEY.

CUSTOM-HOUSE, BRIDGETON, N. J.,
Collector's Office, June 29, 1886.

In reply to yours of the 21st instant, I have to report that there is no revenue collected in this district. We have no imports; the only money we ever collected was marine-hospital dues (and that tax was abolished two years ago), and occasionally some small sums in the way of steamboat-inspection fees; the last mentioned amounted, during the year now about closed, to $64.30.

Very respectfully,

J. H. ELMER,
Collector Customs.

WM. F. SMITH.

G 2.

IMPROVEMENT OF WILMINGTON HARBOR, DELAWARE.

The work of improvement of this harbor has been limited during the present fiscal year, owing to the inadequate amount of money available to do the next most important part of the project, *i. e.*, to construct an extension to the jetty at the entrance. During the year the old sunken crib off Lobdell's Canal was removed, and also the two light-house wharves. near the entrance of the harbor, were pulled down and the material put on the embankment, as agreed with the Light-House Establishment.

These obstructions had a tendency to increase the difficulties of navigation by choking and jamming the floating ice during the spring months, and also checked the velocity of the tides and caused shoals at these places.

A channel was dredged through the draw at Market Street Bridge to a depth of 15 feet, at mean low water, and a width of 80 feet. The amount of material removed from this locality is 3,650 cubic yards, measured in place, and it consisted of gravel, sand, and blue clay, 12 bowlders, varying in size from one half to 2½ cubic yards, and 32 piles.

The raising of the jetty seems to have done away with the shoaling from a point about midway of the jetty out to the Delaware River, and the depth of channel dredged in 1884, connecting the 15-foot curve in the Delaware with the 15-foot curve inside the harbor, had been maintained at the last examination. The present angle of collision of the currents of the Delaware and Christiana will, however, always produce a bar at the mouth, and this can only be obviated by the carrying out of the approved project for the extension of the jetty.

The amount asked for the fiscal year ending June 30, 1888, is $75,000, and if appropriated, together with the balance available, will be applied to the extension of the jetty and dredging the channel to a depth of 15 feet, to the Pulp Works.

Wilmington is a port of entry, and in the collection district of Delaware. The amount of revenue collected for the last fiscal year is $16,011.97.

AMOUNTS APPROPRIATED.

By act approved July 14, 1836	$15,000
By act approved March 3, 1837	8,000
By act approved July 7, 1838	9,356
By act approved July 11, 1870	15,000
By act approved June 10, 1872	10,000
By act approved March 3, 1873	6,000
By act approved June 23, 1874	6,000
By act approved March 3, 1875	10,000
By act approved August 14, 1876	16,000
By act approved June 18, 1878	7,000
By act approved March 3, 1879	3,500
By act approved June 14, 1880	10,000
By act approved March 3, 1881	50,000
By act passed August 2, 1882	50,000
By act approved July 5, 1884	25,000

Money statement.

July 1, 1885, amount available	$17,043 23
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,927 32
July 1, 1886, amount available	13,115 91
Amount appropriated by act approved August 5, 1886	18,750 00
Amount available for fiscal year ending June 30, 1887	31,865 91
Amount (estimated) required for completion of existing project	147,634 00
Amount that can be profitably expended in fiscal year ending June, 30, 1888	75,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, WILMINGTON, DEL.,
Collector's Office, July 27, 1886.

SIR: In response to your request I have to inform you that the total collections in this district during the fiscal year ending June 30, 1886, amount to $16,011.97. The number of vessels permanently documented in the district is as stated below, viz:

Class.	Number.	Gross tonnage.	Net tonnage.
Sail vessels	147	12,662 34	12,030.40
Steam vessels	28	4,092.30	3,176.60
	175	16,754.64	15,207.00

Very respectfully,

HENRY F. PICKELS,
Collector.

General WM. F. SMITH.

G 3.

ICE-HARBOR AT NEW CASTLE, DELAWARE.

Nothing was done on the improvement of this harbor during the past fiscal year for want of funds. The harbor is formed by piers (diamond shaped) of wooden cribs, filled to low-water mark with stone and capped with about 6 feet of dressed stone.

These piers are much in need of repairs, and the area of the harbor should be increased by dredging. A full report of the condition of the piers and an estimated cost of the needed improvement will be found in the Annual Report of the Chief of Engineers for 1885, Part I, pages 874 and 875.

The harbor at New Castle is of great importance to the general commerce on the Delaware River, and its benefit to the city itself only indirect. A large number of vessels seek refuge there during the season of running ice. None of them belong to the city of New Castle, and it thus becomes of interest to several States.

The ice-harbor of New Castle is in the collection district of Delaware, and Wilmington is the nearest port of entry. The amount of revenue collected there during the past fiscal year is $16,011.97.

AMOUNTS APPROPRIATED.

By act approved May 20, 1826	$25,000 00
By act approved March 2, 1829	17,895 99
By act approved July 2, 1836	25,000 00
By act approved March 3, 1837	10,000 00
By act approved July 7, 1838	11,573 00
By act approved August 30, 1852	15,000 00
By act approved July 15, 1870	2,500 00
By act approved June 10, 1872	27,000 00
By act approved March 3, 1873	20,000 00
By act approved June 27, 1874	10,000 00
By act approved March 3, 1875	20,000 00
By act approved August 14, 1876	12,000 00
By act approved June 18, 1878	10,000 00
By act approved March 3, 1879	5,500 00
By act approved June 14, 1880	3,000 00
By act approved March 3, 1881	20,000 00
By act approved July 5, 1884	2,000 00

Of the above appropriations $18,285.05 has been turned into the surplus fund of the Treasury.

Money statement.

Amount appropriated by act approved August 5, 1886	$5,000 00
Amount (estimated) required for completion of existing project	15,600 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	15,600 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

G 4.

IMPROVEMENT OF DUCK CREEK, DELAWARE.

Nothing has been done during the fiscal year ending June 30, 1886, for want of funds, and I am unable for the same reason to state the condition of the work at that time. It is proposed to apply the appropriation asked for the fiscal year ending June 30, 1888, to removing the shoals in the bed of the stream from the mouth of the river to the town of Smyrna. The commerce on the creek is not deemed sufficient to justify the expenditure necessary for the improvement of the mouth.

Duck Creek is in the collection district of Delaware. Wilmington is the nearest port of entry, and the revenue collected there for the last fiscal year amounted to $16.011.97.

AMOUNTS APPROPRIATED.

By act approved June 14, 1880	$5,000 00
By act approved March 3, 1881	3,000 00
By act passed August 2, 1882	2,000 00
Total	10,000 00

Money statement.

Amount (estimated) required for completion of existing project	$12,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	12,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

OFFICE PHILADELPHIA AND SMYRNA TRANSPORTATION COMPANY,
Smyrna, Del., July 1, 1886.

DEAR SIR: In accordance with request contained in your favor of 21st ultimo, we herewith submit the following estimate of the business and shipping interests of Duck Creek, Delaware:

Articles.	Quantity.	Value.
Coal ... tons	7,000	42,000
Iron and steel ... do	600	20,000
Hay, salt and fresh ... do	700	9,000
Fertilizers ... do	20,000	500,000
Lumber ... feet	1,500,000	75,000
Grain ... bushels	400,000	350,000
Lime ... do	150,000	20,000
Fruit—peaches, &c ... baskets	750,000	375,000
Peach baskets	500,000	50,000
Evaporated and canned goods	.....	250,000
Live stock ... head	7,000	175,000
Agricultural implements	....	100,000
Merchandise (about)	....	900,000
Total	....	2,866,000

In addition to above there is considerable commerce, consisting of such articles as truck, eggs, fish, poultry, oysters, &c. Besides, one iron propeller steamboat, drawing 6½ feet water, say three to five schooners, 30 to 80 tons' capacity, drawing 5 to 6½ feet water, several sloops and fishing vessels, also three to five barges, capacities, 100 to 250 tons, draught about 6½ feet; these comprise the fleet navigating this stream. The above estimates are made as nearly as possible from the business coming under our observation, and of course is subject to the increase of irregular trades.

Respectfully submitting the above, we are, very truly,
THE PHILADELPHIA AND SMYRNA TRANSPORTATION COMPANY.

General WM. F. SMITH,
United States Agent.

G 5.

IMPROVEMENT OF SAINT JONES RIVER, DELAWARE.

As reported last year, a contract was made in December, 1884, for the improvement of this river by straightening and deepening the channel to 6 feet at mean low water wherever a less depth was found, and to a width of 40 feet; also to make a cut-off at Cherry Tree Bend of the same width and depth, and widen another near Dover. The work was to commence at the mouth and continue up-stream as far as the available money would permit, but the dredge having been constructed at Dover it was necessary to dredge a distance of 941 feet down-stream before the natural depth of water sufficient to float the dredge was reached.

The channel was dredged 6 feet deep at low water and 40 feet wide, and a turning-basin 180 feet in length and 80 feet wide was also made at Dover in accordance with the project. Commencing at the second shoal inside the mouth of the river and working up-stream, a 6-foot low-water channel 40 feet in width was dredged at the following shoals:

Locality.	Length.	Locality.	Length.
	Feet.		*Feet.*
Warren's Landing Shoal	825	Phosphate Factory Shoal	1,385
Jack's Point Shoal	340	James Island Shoal	1,000
Logan's Landing Shoal	600	Babbitt's Fishery Shoal	766
Hevern's Landing Shoal	550	Wharton's Fishery Shoal	750
Red Granary Shoal	1,500	Lebanon Shoal	330
White Store Landing Shoal	2,000	Lebanon Reach and Mud Hole Point	2,270

At Cypress Point the channel was widened 33 feet for a length of 345 feet, depth 6 feet; and at Cherry Tree Bend a cut-off was made 1,020 feet long, 40 feet in width, and 6 feet deep at mean low water. The right of way through land for this cut-off was given to the United States free of cost. The benefit to navigation by this cut-off is a saving in distance of about 4,000 feet, besides avoiding the abrupt bends in the river at this locality.

After the above-named work had been done the dredge was removed again down the river, and work commenced at Broad Reach Shoal, the first shoal inside the mouth. At this shoal a channel was dredged 2,270 feet to a depth of 6 feet at mean low water and a width of 40 feet.

The total distance dredged during the year is 17,072 feet, and the total amount of material removed is 54,128 cubic yards, measured in place, which was deposited on the banks of the river 50 feet from edge of channel.

The balance of funds available June 30, 1886, will be applied to the completion of the channel through Broad Reach Shoal and to continuing the channel above Lebanon.

Work under this contract will probably be completed by the end of July. It is proposed to apply the appropriation asked for the fiscal year ending June 30, 1888, to the continuance of the improvement of the river for a 6-foot low-water navigation to Dover.

Dover is in the collection district of Delaware. Wilmington is the nearest port of entry, at which the amount of revenue collected for the last fiscal year is $16,011.97.

AMOUNTS APPROPRIATED.

By act approved March 3, 1881	$5,000
By act approved July 5, 1884	10,000
Total	15,000

Money statement.

July 1, 1885, amount available		$14,162 11
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$11,546 08	
July 1, 1886, outstanding liabilities	1,122 44	
		12,668 52
July 1, 1886, amount available		1,493 59
Amount appropriated by act approved August 5, 1886		10,000 00
Amount available for fiscal year ending June 30, 1887		11,493 59
Amount (estimated) required for completion of existing project		10,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		10,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

G 6.

IMPROVEMENT OF MISSPILLION CREEK, DELAWARE.

No work has been done on the improvement of this stream during the fiscal year ending June 30, 1886, for want of funds, and the condition of the work at that time is not known for the same reason.

It is estimated that $3,500 will complete the project for the improvement of the creek, by removing the remainder of the shoals between Milford and the mouth of the creek, which will give a 6-foot low-water navigation for the entire distance. This improvement will be of great benefit to navigation and commerce interested by lessening the time required to get up and down the stream.

If the bar at the mouth is to be improved it is estimated that $55,000 additional will be required, but it is doubtful if the commerce on this creek will justify this expenditure.

Mispillion Creek is in the collection district of Delaware. Wilmington is the nearest port of entry, at which the revenue collected for the last fiscal year, was $16,011.97.

AMOUNTS APPROPRIATED.

By act approved March 3, 1879	$3,000
By act approved June 14, 1880	4,000
By act approved March 3, 1881	3,500
By act passed August 2, 1882	3,000

Money statement.

Amount (estimated) required for completion of existing project	$58,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	3,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

G 7.

IMPROVEMENT OF BROADKILN RIVER, DELAWARE.

The history of this improvement is given in the Annual Report of the Chief of Engineers for 1881, beginning on page 780.

A project adopted for the improvement of this river with the funds available at the end of last fiscal year, was to dredge a channel 40 feet wide and 6 feet deep at mean low water, wherever a less depth was found between the mouth of the river and Milton, Del., and to cut off certain sharp bends interfering with navigation.

After due advertisement a contract was made with the American Dredging Company of Philadelphia to execute the work. The dredging was commenced promptly and continued till December, 1885, when the project was completed and the funds exhausted.

The total distance dredged was 24,225 feet, and the total amount of material removed was 92,737 cubic yards. A channel was made from the junction of Lewes Creek to Milton, 6 feet in depth at mean low water, with a width in no place less than 40 feet; six bends in the river were widened to 60 and 70 feet. The mean rise of tide at Milton, before the improvement commenced, was 1.8 feet; it is now 3 feet. I am also informed by captains of vessels that the water over the bar at the mouth has increased fully 1 foot since the improvement has been made. Vessels are now able to go from Milton to the mouth of the river at any stage of the tide, and not more than one half day is required to make the trip; before the improvement it took two and three days. This has been a great benefit to navigation, and an increased trade on the river will eventually follow.

Milton, at the head of navigation, is a thriving town, and the shipping point for a large and fertile section of country.

The work is in the collection district of Delaware. Wilmington is the nearest port of entry, at which the amount of revenue collected for the last fiscal year is $16,011.97.

AMOUNTS APPROPRIATED.

By act approved March 3, 1873	$10,000
By act approved June 14, 1880	5,000
By act approved March 3, 1881	5,000
By act passed August 2, 1882	5,000
Total	25,000

Money statement.

July 1, 1885, amount available	$13,254 08
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	13,254 08
Amount (estimated) required for completion of existing project	31,500 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received and opened at 12, noon, of July 16, 1885, for dredging in Broadkiln River, Delaware, by Mr. William F. Smith, United States Agent.

No.	Names and addresses.	Time.		Price per cubic yard (place measurement).	Price per cubic yard (scow measurement).
		Commence.	Complete.		
				Cents.	*Cents.*
[1] 1	American Dredging Company, Philadelphia, Pa.	Aug. 1, 1885	Oct. 1, 1885	12	....
2	National Dredging Company, Wilmington, Del.	....	Nov. 1, 1885	14	....
3	Frank C. Somers, Philadelphia, Pa	Aug. 1, 1885	Dec. 31, 1885	18¾	18¾
4	George E. Ward, Edenton, N. C	Oct. 1, 1885	Apr. 30, 1886	12⅞	15
[2] 5	Frank Pidgeon, New York, N. Y	....	......	17 3/10	14⅞
[3] 6	John Satterlee, Englewood, N. J	Not stated	Not stated	....	....

[1] Measured in bucket; 7 cents per cubic yard.

[2] Commence and finish within the fiscal year.

[3] Nineteen cents per cubic yard. Mode of measurement not stated.

G 8.

IMPROVEMENT OF BROAD CREEK, FROM ITS MOUTH TO LAUREL, DELAWARE.

The history of this improvement and of the existing project is given in the Annual Report of the Chief of Engineers for 1883.

Nothing was done on this improvement during the fiscal year ending June 30, 1886, for want of funds, and for the same reason the condition of the work at that date is not known. The amount asked for the fiscal year ending June 30, 1888, will be applied to the continuance of the project for a 6-foot low-water navigation to the town of Laurel, with a width of channel of 50 feet, and protecting it with dikes.

Broad Creek is in the collection district of Delaware. Wilmington is the nearest port of entry, at which the amount of revenue collected for the fiscal year ending June 30, 1886, is $16,011.97.

AMOUNTS APPROPRIATED.

By act approved June 14, 1880	$5,000
By act approved March 3, 1881	10,000
By act passed August 2, 1882	5,000
Total	20,000

Money statement.

Amount (estimated) required for completion of existing project	$32,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	32,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

LAUREL, DEL., *June* 29, 1886.

In reply to the within communication, we have only to say that the commerce interested in the improvement of Broad Creek remains substantially the same as is found in your report of 1885, on page 881, Appendix H, with the exception of the addition of a steam freight-boat of a carrying capacity of 200 tons, trading from Laurel to Baltimore and Philadelphia. Hoping the above, with the statistics embodied in your above-mentioned report of 1885, may be satisfactory,

I am, most respectfully,

J. TURPIN MOORE.

General WM. F. SMITH.

G 9.

IMPROVEMENT OF INDIAN RIVER, DELAWARE.

Nothing done on this improvement during the fiscal year ending June 30, 1886, for want of money, and the condition of the work at that date is not known for the same reason.

Indian River is in the collection district of Delaware. The nearest port of entry is Wilmington, at which the revenue collected during the last fiscal year amounted to $16,011.97.

AMOUNT APPROPRIATED.

By act passed August 2, 1882	$10,000

Money statement.

Amount (estimated) required for completion of existing project	$50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

G 10.

IMPROVEMENT OF THE CHANNEL OF THE SUSQUEHANNA RIVER ABOVE AND BELOW HAVRE DE GRACE, MARYLAND.

The river and harbor act of July 5, 1884, appropriating $20,000 for this improvement, required "$5,000 shall be expended for the completion of the channel to Fishing Battery light-house, and for repairing, strengthening, and extending the piers and breakwaters." This work was done in the fall of 1884, and a report of which is given in the Annual Report of the Chief of Engineers for 1885. The balance of the appropriation was applied to dredging, by contract made with the Baltimore Dredging Company after due advertisement. Only a small amount of work under this contract had been done at the close of last fiscal year, as the commencement was delayed so as not to interfere with the shad-fishing interest.

The contract required a channel to be dredged through the two shoals below the railroad bridge at Havre de Grace 100 feet wide and 12 feet deep at mean low water, and the dredging off of the shoal at Watson's Island to a depth of 8 feet at mean low water, as far as the available funds would permit.

Commencing at the shoal just above the light-house at Fishing Battery, a channel was dredged 2,225 feet in length, 12 feet deep, and 100 feet wide. The other shoal below the bridge disappeared, although it existed in the fall of 1884, when an examination was made of the channel. The shoal near Watson's Island was dredged back from its eastern edge a distance of 200 feet, in length about 3,700 feet and to a depth of 8 feet at mean low water. Work was suspended in December, 1885, owing to the near exhaustion of the funds. The total amount of material removed under this contract was 63,433 cubic yards measured in place.

A total width of 400 feet has been cut off the shoal near Watson's Island, and the improvement has been of great benefit in lessening the effect of the ice-gorges, so damaging to property.

Continuing the estimate of last year, under the alternative seemingly adopted by Congress, the amount that can be profitably expended during the fiscal year ending June 30, 1888, is $20,000, and, if appropriated, will be applied to maintaining the 15-foot navigation below Havre de Grace, and the balance applied to continuing the work of cutting off the shoal at Watson's Island, to diminish the tendency of the ice to gorge. The cutting off this shoal should continue until ice-gorges have been relieved.

Susquehanna River is in the collection district of Baltimore. Baltimore is the nearest port of entry, at which the amount of revenue collected for the last fiscal year is $———.

AMOUNTS APPROPRIATED.

By act approved August 30, 1852	$10,000
By act approved June 23, 1866	26,400
By act approved July 11, 1870	12,000
By act approved June 14, 1880	28,000
By act approved March 3, 1881	15,000
By act passed August 2, 1882	25,000
By act approved July 5, 1884	20.000
Total	136,400

Money statement.

July 1, 1885, amount available	$11,643 87
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	11,224 80
July 1, 1886, amount available	419 07
Amount appropriated by act approved August 5, 1886	6,000 00
Amount available for fiscal year ending June 30, 1887	6,419 07
Amount (estimated) required for annual dredging	20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

LETTER OF COLLECTOR OF CUSTOMS AT BALTIMORE, MARYLAND.

CUSTOM-HOUSE, BALTIMORE, MD.,
Collector's Office, July 28, 1886.

SIR: In reply to your request of the 23d ultimo, to be furnished with statistics of the several tributaries of the Chesapeake Bay, with a view of embodying the same in your annual report to Congress, I have to say that I have been unable so far to obtain the information you desire from some of the points named. Should replies be received later, I will forward them to you.

From the Susquehanna River near Havre de Grace I have received no reply.

* * * * * * *

I am, very respectfully,

JAMES B. GROOME,
Collector.

General WM. F. SMITH,
U. S. Agent.

G 11.

IMPROVEMENT OF CHESTER RIVER, AT KENT ISLAND NARROWS, MARYLAND.

Nothing done at this locality since 1877.

Chester River is in the collection district of Baltimore, which is also the nearest port of entry, at which the revenue collected for the last fiscal year amounted to $——.

AMOUNTS APPROPRIATED.

By act approved March 3, 1873	$15,000
By act approved June 23, 1874	5,000
By act approved August 14, 1876	5,000
By act approved June 18, 1878	3,000
	28,000
Amount expended	25,500
Balance	2,500

Money statement.

July 1, 1885, amount available	$2,500 00
July 1, 1886, amount available	2,500 00

G 12.

IMPROVEMENT OF CHESTER RIVER, FROM SPRY'S LANDING TO CRUMPTON, MARYLAND.

Nothing done at this locality since the completion of the original project in July, 1883.

A history of the work is given in the Annual Report of the Chief of Engineers for 1884, page 893; and for the benefits derived from the improvement made see commercial statistics given below.

AMOUNTS APPROPRIATED.

By act approved March 13, 1881	$6,500
By act passed August 2, 1882	6,500
Total	13,000

COMMERCIAL STATISTICS.

Furnished through the courtesy of Hon. James B. Groome, collector customs, Baltimore.]

From Chester River, Capt. W. D. Burchinal, after referring to his letter of last year says:

"The advantages derived from the appropriations already made in deepening the channel at various points on the Chester River, were to an extent shown in the report referred to, but of course trade has gradually increased since, consequent upon the rapid building up of the towns and villages that were previously inaccessible to vessels of other than those of very light draught of water, owing to bars and shoals that had made across the channel.

"There has been no waste in the expenditure of money in the improvements in Chester River, and the citizens bordering upon this beautiful stream, as well as those navigating the same, feel under great obligations to Congress for the appropriations already made and to Colonel Craighill and those engaged with him in the proper and judicious management of the work."

G 13.

IMPROVEMENT OF CORSICA CREEK, MARYLAND.

The work on this improvement was suspended in May, 1885, on account of the near exhaustion of the appropriation, and nothing has been done since for want of funds.

The estimated amount necessary for completion of the improvement in accordance with the adopted project is $20,000. That amount is asked for the fiscal year ending June 30, 1888, and, if appropriated, will be applied to extending the channel to the county wharf, dredging a turning-basin, and increasing the width of the channel its entire length from 80 to 100 feet, as originally recommended.

The commerce of this locality is very large, and the steamers and vessels navigating the stream require a channel of 100 feet in width.

Corsica Creek is in the collection district of Baltimore. Baltimore is the nearest port of entry, at which the amount of revenue collected for the last fiscal year is $——.

AMOUNTS APPROPRIATED.

By act passed August 2, 1882	$5,000
By act approved July 5, 1884	5,000
Total	10,000

Money statement.

July 1, 1885, amount available	$308 86
July 1, 1886, amount available	308 86
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,308 86
Amount (estimated) required for completion of existing project	10,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[Furnished through the courtesy of Hon. James B. Groome, collector customs, Baltimore.]

From Corsica Creek, near Centreville, Md., Mr. William McKenney writes:

"Centreville is situated at the head of Corsica River, and is the county town of Queen Anne's County, which, by the last census, is the leading-wheat growing county on the Eastern Shore of Maryland, and is only excelled by four other counties in the State.

"The shipments from Centreville Landing by Corsica River reach about 500,000 bushels of wheat, corn, and oats, 4,000 tons fertilizers and phosphates, 2,000 tons coal, 800,000 feet of lumber, 500,000 shingles, 1,000,000 laths, 2,500 tons of square timber, 500,000 bricks, 50,000 bushels of lime, 2,000 sheep, cattle, and mules; fish, oysters, &c., in large quantities; large trade in poultry, bacon, flour, &c., besides 100,000 bushels of shells, 800 sacks of salt, and 100,000 boxes of peaches.

"Four schooners and 2 steamboats trade regularly between Centreville and Baltimore, with several other steamers during the peach season, and various other vessels with lime, shingles, lumber, coal, &c.

"At Centreville Landing there are granaries with storage capacity for over 200,000 bushels of grain, in addition to storage capacity for fertilizers, salt, provisions, &c. A phosphate factory, a cannery, and a fruit drier are also located at that point. The landing has a wharf front of over 500 yards in length. In addition to the wharves at Centreville Landing there are on Corsica River 8 others. The population of the town is about 1,600 and of the landing about 200.

"Total amount of the business of Centreville and the landing is estimated at $1,100,000.

"Centreville is the terminus of the Queen Anne's and Kent Railroad, with two passenger and one freight trains daily connecting with northern-bound trains.

"Over this road a heavy business is done in grain, lime, coal, lumber, and general merchandise.

"Corsica River is now navigable for vessels and steamers of light draught.

"If the channel is deepened and widened sufficiently to allow suitable passenger steamers to reach Centreville Landing, a large travel by water to and from Baltimore will be secured. Centreville is in the Baltimore collection district, the nearest lighthouse being Love Point, at the mouth of Chester River."

LETTER OF MR. JOHN H. OZMON.

CENTREVILLE, *June* 29, 1886.

DEAR SIR: In reply to yours of the 21st instant, I would say what is shipped to and from Corsica River (formerly Corsica Creek) is about 200,000 bushels of wheat, 150,000 bushels of corn, 50,000 bushels of rye and oats, 300,000 crates or baskets of fruit, 100 tons of iron, about $500,000 worth of merchandise, 3,000 tons of coal, 800,000 shingles, 1,000,000 feet of lumber, 150,000 feet of square lumber, 1,000,000 laths, 440,000 bricks, 3,000 barrels of flour, 60,000 bushels of lime for agricultural purposes, 1,500 bushels of lime for building purposes, 60,000 bushels of oyster-shells, 1,000 barrels of fish, 1,000 sacks of salt, 2,500 tons of phosphate, several vessel loads of quarry stones, besides large quantities of horses, cattle, sheep, calves, Irish and sweet potatoes, cabbage, &c.

There are four schooners that ply between this place and Baltimore regularly of capacity 4,000 bushels each. Two steamboats run tri-weekly between this landing and Baltimore, and weekly we have larger and smaller crafts stopping here landing various articles of freight. We consider that the deepening of the channel of Corsica Creek of vast importance, as we are enabled now to make three trips in the same time it formerly took us to make two; besides, now it permits vessels and steamers of heavy draught to arrive and depart from our landings with dispatch. We think if Congress were to make an additional appropriation, enough, say, to widen our channel and deepen further up the creek, our trade would be largely enhanced.

JOHN H. OZMON.

General WM. F. SMITH.

G 14.

IMPROVEMENT OF CHOPTANK RIVER BETWEEN DENTON AND GREENSBOROUGH, MARYLAND.

The work on this improvement was suspended in May, 1885, on account of the near exhaustion of the appropriation. Nothing has been done since for want of funds.

The result of the work on this improvement has been to give a channel 6 feet deep at mean low water to Case's Wharf, at Greensborough, and through the shoal opposite Case's a depth of 5 feet. The width of the channel varies from 47 feet to 75 feet. It is proposed to apply the appropriation asked for the fiscal year ending June 30, 1888, in carrying out the original project to give a channel 8 feet deep at mean low water and 75 feet in width by deepening and widening the channels already dredged through the shoals between the towns of Denton and Greensborough.

Choptank River is in the collection district of the Eastern district of Maryland. Baltimore is the nearest port of entry, and the amount of revenue collected there for the last fiscal year is $ ——.

AMOUNTS APPROPRIATED.

By act approved June 14, 1880	$5,000
By act approved March 3, 1881	5,000
By act passed August 2, 1882	5,000
By act approved July 5, 1884	5,000

Money statement.

July 1, 1885, amount available	$109 28
July 1, 1886, amount available	109 28
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,109 28
Amount (estimated) required for completion of existing project	47,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	47,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Articles.	Quantity.	Articles.	Quantity.
Grain .... bushels..	300,000	Coal .... tons..	1,000
Phosphates .... tons..	1,500	Merchandise........	$200,000
Bricks	300,000	Canned goods........ cases..	800,000
Lumber........ feet..	1,000,000	Oyster shells........ bushels..	500,000
Lime........ bushels..	25,000	Fruit........ baskets..	75,000

LETTER OF MR. WILLIAM MASSEY.

DEAR SIR: I have consulted several of the leading business men and obtained their views, and above you will find the estimate of the amount of business of this section. The fruit business will increase very much in the next few years, and, Baltimore being one of the largest canning cities in the country, the bulk will be shipped by water when the river is in a condition to let steamers up to this place. At present there are 4 schooners of about 100 tons and 2 large steamers that come within 8 miles.

Respectfully,

WM. MASSEY.

General WM. F. SMITH.

G 15.

IMPROVEMENT OF WICOMICO RIVER FROM ITS MOUTH TO SALISBURY, MARYLAND.

The work remaining to be done at the close of the fiscal year 1885 to complete the project for straightening and widening the 7-foot channel between Salisbury and the old steamboat wharf below, a distance of about 2 miles, was 2,217 feet. This was done in July, 1885, under the contract with P. Sanford Ross. The channel between the points named has been widened and straightened by cutting off the convex side of the bends to a width varying from 90 to 145 feet, maintaining the depth of 7 feet at mean low water. This work was done with the appropriation of July 5, 1884, of $10,000. The improvement has been of great benefit to navigation. A larger class of boats run on the river, and the trade has greatly increased.

Wicomico River is in the collection district of the Eastern district, Maryland. Crisfield is the nearest port of entry, at which the amount of revenue collected during the last fiscal year is $ ——.

AMOUNTS APPROPRIATED.

By act approved June 10, 1872	$5,000
By act approved March 3, 1873	5,000
By act approved June 23, 1874	5,000
By act approved March 3, 1875	5,000
By act approved August 14, 1876	5,000
By act approved June 18, 1878	5,000
By act approved March 3, 1879	3,000
By act approved June 14, 1880	5,000
By act approved March 3, 1881	2,000
By act approved July 5, 1884	10,000

Money statement.

July 1, 1885, amount available	$4,478 16
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,105 36
July 1, 1886, amount available	1,372 80

G 16.

IMPROVEMENT OF UPPER THOROUGHFARE BETWEEN DEIL'S ISLAND AND THE MAINLAND, MARYLAND.

Nothing has been done at this locality during the year ending June 30, 1886, the money available being inadequate to commence operations.

This improvement is in the collection district of Eastern district, Maryland; Crisfield is the nearest port of entry. The amount of revenue collected there for the last fiscal year is $ ——.

AMOUNT APPROPRIATED.

By act passed August 2, 1882	$5,000

Money statement.

July 1, 1885, amount available	$4,669 91
July 1, 1886, amount available	4,669 91
Amount (estimated) required for completion of existing project	15,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	15,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

[Furnished through the courtesy of Hon. James B. Groome, collector customs, Baltimore.]

From Crisfield, Upper Thoroughfare, and Deil's Island the collector of customs at Crisfield, Mr. Hance Lawson, writes as follows: No material change in the commerce and trade of the above-mentioned localities has occurred since my last report. Hence my answer to your inquiries will be based on that report, with such changes as have been brought under my notice.

Crisfield, on the Annamessex River, is the port of entry of the district of Eastern Maryland, the terminus of the Crisfield branch of the New York, Philadelphia and Norfolk Railroad, and the principal landing place of the Eastern Shore Steamboat Company, running a daily line of steamers from Baltimore to the Eastern Shore of Maryland and Virginia.

The number of vessels enrolled and licensed at this port is 888, of which number 580 are owned in Somerset County (in which Crisfield is situated), 230 are owned in Dorchester, 65 in Wicomico County, and 13 in Worcester County. The commerce of the port is exclusively in the coasting trade, and the revenue derived therefrom is small, amounting during the year past, ending May 31, to $1,505.86. The trade of the town of Crisfield includes oyster-packing in its various forms, fish, ship-building, manufacture of fish scraps and fertilizers, general merchandise, lumber, coal, wood, &c.

The oyster-packing industry is carried on by 12 establishments, giving employment to over 900 hands, and 250 vessels, owned in and around the immediate neighborhood, employing 1,500 men, and with an invested capital of $450,000.

Over 900,000 bushels of oysters were landed at the port during the past year, valued at $270,000. There are 2 ship-yards and marine railways, 1 factory for the manufacture of fish-scrap and fertilizers, and 1 machine-shop, and 70 general stores, doing a business of $475,000 annually. I would name as the principle articles of trade:

Articles.		Quantity.	Value.
Coal	tons..	3,500	$17,500
Wood	cords..	1,500	6,000
Iron	tons..	600	24,000
Lumber	feet..	1,500,000	180,000

A comparatively new business, the catching and shipping of crabs, is assuming large proportions. It gives employment during the summer months to over 500 men and boys, with nearly the same number of small boats, and amounts in value to about $30,000 per year.

The Annamessex River is lighted with two light-houses: Somer's Cove Light, 1 mile from Crisfield, and James Island Light, 2¼ miles.

Upper Thoroughfare, Deil's Island, is a secure harbor for a section which relies almost entirely on the waters as a means of transportation. Its trade consists of oyster dredging and tonging, fish, general merchandise, trucking, and farming.

There are over 400 vessels in the neighborhood engaged in the oyster and fish business, employing 1,600 men, taking annually 450,000 bushels, valued at $135,000; about 6,000 bushels corn; 3,500 bushels white and sweet potatoes, and large numbers of water-melons. Truck of different kinds and fruits are transported, and there are 20 general stores, selling goods to the amount of over $100,000 per annum.

APPENDIX H.

IMPROVEMENT OF PATAPSCO RIVER AND CHANNEL TO BALTIMORE, MARYLAND, AND OF THE HARBOR OF ANNAPOLIS, MARYLAND.

REPORT OF LIEUTENANT-COLONEL WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, WITH OTHER DOCUMENTS RELATING TO THE WORK.

IMPROVEMENTS.

1. **Patapsco River and Channel to Baltimore, Maryland.**
2. **Annapolis Harbor, Maryland.**
3. Removing sunken vessels or craft obstructing or endangering navigation.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., August 12, 1886.

GENERAL: I have the honor to forward herewith the annual reports for the year ending June 30, 1886, for the works of improvement of rivers and harbors which have been in my charge.

In cases where the commercial statistics may not be as full and complete as desirable, it is not for want of effort on my part to have them so.

I have also been during the year supervising engineer of the districts in charge of Captains Bixby and Hinman, Corps of Engineers, and of Mr. S. T. Abert, United States agent, and of the district of Mr. W. F. Smith, United States agent, until November 28, 1885.

In addition I have been a member of several special Boards of Engineers, as reported in the regular monthly reports.

I resumed the charge of the improvement of the harbor of Annapolis, Md., December 20, 1885, receiving it from Mr. W. F. Smith, United States agent.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Lieut. Col. of Engineers.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

H 1.

IMPROVEMENT OF CHANNEL TO BALTIMORE, MARYLAND.

For want of funds the work of improvement was entirely suspended during the whole of the year ending June 30, 1886.

The available widths of the successive divisions of the channel, with a depth of 27 feet at mean low water, were, June 30, 1885, at the close of operations, the following:

	Feet.
Craighill Channel	300
Cut-off Channel	300
Brewerton Channel	250
Fort McHenry Channel	250

Advantage was taken of the absence of the dredges, with their numerous attendant tugs, scows, &c., to make a thorough resurvey of the whole channel, the map of which has been prepared, with the above general indications.

The channel left in an unfinished condition more than a year has deteriorated considerably. The estimate of a year ago, for its completion to a uniform width of 400 feet, was $200,000. This is now increased to $230,000, of which sum $150,000 have been appropriated by the law of August, 1886.

Care has been taken of the property belonging to this improvement, and in the office there has been the usual routine work of studies, reports, accounts, correspondence, records, &c.

Money statement.

July 1, 1885, amount available	$30,846 41
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	6,052 97
July 1, 1886, amount available	24,793 44
Amount appropriated by act approved August 5, 1886	150,000 00
Amount available for fiscal year ending June 30, 1887	174,793 44
Amount (estimated) required for completion of existing project	80,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	80,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, BALTIMORE, MD.,
Collector's Office, July 27, 1886.

SIR: In compliance with your request of the 6th of May last, you are herewith furnished with a statement of the commerce of the port of Baltimore for the fiscal year ending the 30th of June, 1886, viz:

VALUE OF IMPORTS.

Free	$6,016,718
Dutiable	5,719,701
Total	11,736,419

COMPARED AS BETWEEN 1885 AND 1886.

Total value of imports, 1885	$11,853,317
Total value of imports, 1886	11,736,419
	116,898

The total value of imports of itself does not afford an intelligent showing of the business of the port in that branch of trade.

A separate comparison of free and dutiable imports will make this apparent:

Value of dutiable imports, 1886	$5,719,701
Value of dutiable imports, 1885	4,833,984
Increase	885,717

* * * * * * *

COMPARISON AS BETWEEN 1885 AND 1886.

Duties collected in 1886	$265,900 53
Duties collected in 1885	184,870 58
Increase in 1886	81,029 95
Duties due on merchandise in bond	155,272 32
Duties due on merchandise in bond, 1885	125,123 03
Increase in 1886	30,149 29

SUMMARY OF DUTIES.

Duties collected		$2,531,822 11
Duties due on merchandise in bond		155,272 32
Duties due on appraised merchandise transported in bond		12,649 70
Duties due on merchandise transported in bond without appraisement		265,900 53
Total		2,965,644 66
Miscellaneous customs receipts	$41,421 88	
Tonnage tax	28,214 15	
		69,636 03
Grand total		3,035,280 69

COMPARISON AS BETWEEN 1885 AND 1886.

Total duties collected and due, 1885	2,314,762 62
Total duties collected and due, 1886	$3,035,280 69
Increase in 1886	720,518 07

* * * * * * *

VALUE OF FOREIGN EXPORTS.

Exports in 1885	$45,041,634
Exports in 1886	35,845,311
Decrease	9,196,323

* * * * * * *

Carried in American vessels:	
Sail	1,555,687
Steam	3,408
Total	1,559,095
In foreign vessels:	
Sail	2,153,267
Steam	32,132,979
Total	34,286,246

NAVIGATION.

Entrances and clearances.	Number.	Tonnage.
Vessels entered from foreign ports.		
American:		
Sail	130	44, 900
Steam	5	896
Foreign:		
Sail	112	69, 001
Steam	319	442, 137
Total	566	556, 934
Vessels cleared for foreign ports.		
American:		
Sail	162	27, 620
Steam	7	1, 311
Foreign:		
Sail	106	65, 309
Steam	350	482, 551
Total	625	576, 791
Vessels entering coastwise	1, 514	948, 690
Vessels clearing coastwise	1, 664	1, 205, 077
Total	3, 178	2, 153, 767

Emigrants arriving in 1885	15, 928
Emigrants arriving in 1886	14, 452
Decrease	1, 476

REGISTERED TONNAGE.

Description.	Number of vessels.	Gross tonnage.	Net tonnage.
Permanent register:			
Sail	51	16, 291. 57	15, 484. 04
Steam	1	622. 25	428. 30
Temporary register:			
Sail	23	12, 208. 56	11, 620. 02
Permanent enrollments:			
Sail	573	30, 594. 08	29, 059. 61
Steam	55	20, 928. 42	15, 468. 14
Barges	9	2, 207. 58	2, 207. 58
Iron vessels, steam	48	31, 099. 73	22, 570. 28
Temporary enrollments:			
Sail	16	4, 833. 88	4, 605. 18
Steam	1	189. 12	189. 12
Licenses under 20 tons:			
Sail	402	4, 534. 94	4, 307. 79
Steam (wooden)	56	1, 169. 85	606. 72
Steam (iron)	4	110. 70	64. 00
Total	1, 239	124, 790. 68	106, 610. 78
Licenses of enrolled vessels in fisheries	10	324. 33	308. 12
Licenses of enrolled vessels coasting	681	95, 286. 16	80, 000. 25
Licenses of enrolled yachts	4	143. 80	122. 75
Total	695	95, 754. 29	80, 431. 12
Vessels built	58	3, 162. 61	2, 399. 41
Vessels lost	39	6, 087. 12	5, 428. 57
Vessels abandoned	5	81. 43	77. 42
Vessels sold to foreigners	2	766. 89	730. 45

The coastwise trade of this port may be properly mentioned in this connection, as it sustains very important relations to the purposes of this exhibit.

The sea-going branch of that trade is of great volume and value, and extends to all points on the Atlantic seaboard and the Gulf of Mexico, and reaches San Francisco.

Ships of heavy tonnage carry coal from this port to the latter place during the year.

The bay and river trade is equally important and valuable, and is steadily growing. Through this trade is received diversified products, which enter largely into the inland and foreign trade of the country.

In conclusion it may be remarked that a review of this exhibit will afford the proof that the growth and expansion of the commerce of this port is not a matter of local concern only, but one of general interest to the country.

I am, very respectfully,

JAMES B. GROOME,
Collector.

Col. WM. P. CRAIGHILL, U. S. A.

H 2.

IMPROVEMENT OF THE HARBOR OF ANNAPOLIS, MARYLAND.

Information was received towards the close of 1885 that shoaling had taken place in some portions of the harbor, and the freedom of navigation was thereby diminished. The necessary survey to determine the condition of the harbor could not be made until April, 1886, on account of continued high winds and ice. The map was completed in May and the work of dredging put under contract in June, 1886, after due advertisement. The contract was awarded to the lowest bidder, the American Dredging Company of Philadelphia. The work will be completed in 1886.

Money statement.

July 1, 1885, amount available	$9,205 98
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	436 99
July 1, 1886, amount available	8,768 99
Amount (estimated) required for completion of existing project	66,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	66,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for dredging harbor at Annapolis, Md., opened at 12.05 p. m., June 17, 1886.

Name.	Time.		In place.	In scows.
	Commence.	Complete.	*Cents.*	*Cents.*
Morris & Cummings Dredging Company	July 1, 1886	Sept. 15, 1886		20
Thomas P. Morgan		Nov. 1, 1886		8⅛
Baltimore Dredging Company	July 1, 1886	Sept. 30, 1886		13
George C. Fobes & Co.	July 1, 1886	Sept. 1, 1886		13⅛
P. Sanford Ross		In 3 months	16¾	11
American Dredging Company		Aug. 10, 1886		8
James Caler & Son.		In 3 months	12	9⅞
National Dredging Company		2 months		9

Contract with American Dredging Company.

H 3.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

By an indorsement of June 11 notice was received from the Chief of Engineers of a wreck near Cove Point, Maryland, with instructions to ascertain whether she was such an obstruction to navigation as to justify her removal by the United States in accordance with the law of June 14, 1880.

Some unavoidable delay occurred in obtaining definite information concerning this wreck. Her locality, condition, &c., were found to be the following: She is a schooner, named B. Oliphant. She sunk February 16, 1886, during a storm, bound out, about five miles NNW. of Cove Point, in Chesapeake Bay. Her tonnage is 63.36 gross; age, about 19 years, and the estimated value of the vessel was $2,000. Her cargo consisted of about 71 tons of guano, which is now believed to be worthless. Both masts show above water. Both vessel and cargo have been abandoned by owners and insurers.

On the statement of the Engineer of the district, July 21, that this wreck was such an obstruction as to be a danger to navigation, and a recommendation that she be removed, authority was given for the removal July 30. Proposals for removal by contract have been called for, and the immediate and entire removal of the obstruction is expected.

APPENDIX I.

IMPROVEMENT OF THE HARBORS AT WASHINGTON AND GEORGETOWN, DISTRICT OF COLUMBIA—IMPROVEMENT OF THE POTOMAC RIVER AT WASHINGTON, DISTRICT OF COLUMBIA—IMPROVEMENT OF JAMES RIVER, VIRGINIA, AND OF SHENANDOAH RIVER, WEST VIRGINIA.

REPORT OF MAJOR PETER C. HAINS, CORPS OF ENGINEERS, BVT. LIEUT. COL., U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Harbors at Washington and Georgetown, District of Columbia.
2. Potomac River at Washington, District of Columbia.
3. James River, Virginia.
4. Shenandoah River, West Virginia.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., July 28, 1886.

SIR: I have the honor to transmit herewith my annual reports on the river and harbor improvements under my charge for the fiscal year ending June 30, 1886.

Very respectfully, your obedient servant,

PETER C. HAINS,
Major of Engineers,
Bvt. Lieut. Col., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

I 1.

IMPROVEMENT OF THE HARBORS OF WASHINGTON AND GEORGETOWN, DISTRICT OF COLUMBIA.

A history of the operations carried on previous to 1883 in the improvement of Washington and Georgetown harbors is given in my annual report for the fiscal year ending June 30, 1883.

At the beginning of the present fiscal year the work of excavating rocks in Georgetown Harbor that obstructed navigation was in progress. Certain groups of rocks, designated by the letters "K," "L," "M," "N," "O," "F," and "C," were at the time being removed under contract with Edward R. Lowe, of New York. The work was completed in November, 1885, and the contract closed. The removal of these rocks makes the harbor of Georgetown safe for vessels drawing 20 feet of water. There are other rocks close in to the wharf at G street, and another ledge that reaches out 50 feet or more from the wharves between the Mill Race to the foot of High street. They are an obstruction only to vessels that tie up near those wharves. Their removal would benefit the owners of wharf property in the vicinity, but at the present time would be of little use to general commerce. In the future it may become necessary to remove them in order to increase the wharfage facilities of Georgetown or to regulate the harbor lines.

It was thought better to leave their removal to be provided for by special act of Congress.

After the completion of the rock excavation there remained a balance of $11,316.17. This sum was saved by reason of the low price at which the work was done. The dangerous rocks in Georgetown Harbor having been removed, the $11,316.17 of the appropriation was reallotted to the dredging of Georgetown Channel, and applied to deepening and widening it above Long Bridge. The material dredged from the channel was deposited on the Potomac Flats.

The amounts appropriated for this work are as follows:

June 11, 1870	$50,000
March 3, 1873	50,000
June 18, 1878	50,000
March 3, 1879	50,000
June 14, 1880	40,000
March 3, 1881	50,000
	290,000

The work is in the collection district of Georgetown, D. C., which is the nearest port of entry. Nearest light-house, Jones Point, Virginia. Revenue collected for the year ending June 30, 1886, $21,364.30.

Money statement.

July 1, 1885, amount available		$18,425 67
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$16,909 79	
July 1, 1886, outstanding liabilities	1,515 88	
		18,425 67

Abstracts of contracts for improving harbors at Washington and Georgetown, D. C., in force during fiscal year ending June 30, 1886.

No.	Name and address of contractor.	Date of contract.	Subject of contract.	Amount.
1	Edward R. Lowe, New York City, N. Y. *	November 5, 1884	Removal of rocks	$7,387

* Completed.

Value of receipts and shipments at the harbors of Washington and Georgetown, D. C. during the fiscal year ending June 30, 1886.

Articles.	Quantity.	Value.
Asphalt .... tons..	3,827	$95,675
Cement .... barrels..	26,865	40,297
Coal, anthracite ... tons..	145,467	727,835
Coal, bituminous ... do...	195,105	536,539
Compost .... do...	16,045	32,090
Fertilizers .... do...	5,495	219,800
Fish .... do...	2,563	153,780
Flour (shipped) . barrels..	88,000	440,000
Grain (wheat and corn), bushels	65,000	52,000
Ice .... tons..	89,717	448,585
Lumber (board measure), feet	32,951,000	527,216
Laths	12,572,500	28,288
Oil .... barrels..	1,651	$6,604
Oysters .... bushels..	236,245	94,498
Paving blocks	245,733	12,286
Potatoes .... barrels..	2,869	5,738
Salt .... sacks..	3,257	4,885
Sand .... tons..	50,000	30,000
Shingles	2,181,100	15,267
Stone .... tons..	8,336	83,360
Water and gas pipe do...	389	17,340
Watermelons	329,190	26,335
Wood .... cords..	25,081	100,824
Total		3,698,242

The following table shows the amount of miscellaneous freight brought to these harbors, and not included in the foregoing:

By steamer from—	Quantity, tons.	Estimated value.
New York	12,500	$1,000,000
Philadelphia	6,300	504,000
Baltimore	2,000	160,000
Norfolk	43,875	1,096,875
By river steamers	21,300	532,500
Total	....	3,293,375

Ferry and local passenger steamers not included.

NUMBER OF VESSELS OF VARIOUS CLASSES ARRIVING AND DEPARTING DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

Steamers drawing from 5 to 15 feet	1,050
Vessels drawing from 10 to 18 feet	708
Vessels drawing from 8 to 10 feet	70
Vessels drawing from 4 to 8 feet	1,116
Barges drawing from 4 to 10 feet	363

Ferry and local passenger steamers not included.

I 2.

IMPROVEMENT OF THE POTOMAC RIVER AT WASHINGTON, DISTRICT OF COLUMBIA.

This improvement was inaugurated by act of Congress passed August 2, 1882, by which an appropriation of $400,000 was made. The next appropriation was made July 5, 1884, and was $500,000. Total amount appropriated, $900,000.

The object of the improvement is to widen and deepen the channels to Georgetown and Washington so as to accommodate the largest vessels that can reach Giesborough Point; to establish the harbor lines, and, at the same time, to raise the marshes and flats on the city front above overflow by the highest freshets, the material taken from the river in widening and deepening the channels to be used in filling the flats. The latter are to be raised until the portion above Long Bridge is 3 feet above the freshet slope of 1877, and the portion below the bridge has the same height at the middle line, from which it will slope toward each channel to the margin of the fill, where it will be 6 feet above mean low tide. A large tidal reservoir, not less than 8 feet deep, will be established between Long Bridge and the sewer-canal, to supply fresh water to the Washington Channel, which channel, at the upper end, will be cut off from communication with the Virginia Channel. A smaller reservoir is to be established near the foot of 17th street for the purpose of flushing the sewer-canal. The large reservoir is to be provided with inlet and outlet gates of ample dimensions to fill it on the flood tide from the Virginia Channel, and empty it on the ebb tide into the Washington Channel. The plan contemplates the removal or rebuilding of the Long Bridge on fewer piers with wider spans, and also that the sewage now discharged into the Washington Channel be intercepted and conveyed to James Creek.

The condition of the river front at the time the first appropriation was made had become so bad in a sanitary point of view, that certain parts of the city had become almost uninhabitable. This was caused by deposits, on the city front, of sediment from the river and the solid matter from the sewers which had formed flats or marshes, covering an area of several hundred acres. The Flats, on which there was a dense growth of marsh-grass and reeds, were covered by water for about one-half the time, and uncovered the other half. In the latter condition they were exposed for a time each day to the rays of the sun, which, in summer, produced favorable conditions for malarial diseases. The Washington and Georgetown channels had not the depth and width that navigation required, and dredging was frequently necessary for the relief of commerce. The depth of water on the bar below Long Bridge was 16 feet, while on the bar above the bridge it was only 15 feet at mean low tide. A narrow channel through each was kept open by repeated dredging, as they immediately shoaled up after a freshet. During the years 1870 to 1881, inclusive, there had been appropriated for dredging these channels and removing rocks in Georgetown Harbor, the sum of $290,000, most of which was expended in trying to maintain a narrow channel of 16 feet at low tide.

At the present time the condition of the work is as follows: The Washington Channel has a depth of 20 feet at low tide along the city front up to Long Bridge, the width being from 200 to 350 feet. The Virginia Channel up to Georgetown has a depth of about 20 feet (except where it has shoaled by recent freshets), and a width varying from 300 to 500 feet. Nearly the entire portion of the Flats known as Section I, viz, that part lying northwestward of the sewer-canal, has been filled up to a height of about 6 feet or more. On Section II, viz, that portion of the Flats between the sewer-canal and Long Bridge, about 6,700 linear feet of embankment forming the margin of the tidal reservoir has been built, and the excavation for the tidal reservoir itself has been commenced. Of Section III, the part of the Flats below Long Bridge, about 212 acres, have been filled to a height above overflow at high tide. Total amount thus far filled to a height above overflow by ordinary high tides, 375 acres.

During the past pear 1,686,183 cubic yards of material were dredged and deposited on the Flats. The most of the dredging was done by means of hydraulic machines of the Von Schmidt pattern, the material being put ashore through pipes.

The first contract with Benson & McNee was for 1,000,000 cubic yards to be dredged from the Washington Channel and deposited on Section III of the Flats. This contract was in progress at the beginning of the fiscal year. It is now practically completed. There only remains about two days' work to be done, when the contract will be closed. The final measurements to determine the exact quantity of material deposited on the Flats under this contract cannot be made for some time, however, owing to the fluid-like condition of that last dredged. Nearly all the material taken from the Washington Channel is soft mud, and when stirred up with water, as is done by the hydraulic dredge, maintains a semi-fluid condition for a considerable length of time. The drying out process is a slow one at best; but in this case, it has been greatly retarded by rainy weather. The price paid for the Washington Channel work is 12.37 cents per cubic yard, measured in place on the Flats after the water has run off and the material is compacted.

Contract No. 2, with Benson & McNee, was for 1,000,000 cubic yards to be dredged from the Virginia Channel above Long Bridge, the dredgings to be deposited on the Flats. This contract is, at the present time, only about one-half completed. The work has been retarded by various causes. The material was found to be more difficult to dredge than was anticipated by the contractors. A large part of it was found to be sand, which is very destructive of the pumping machinery. Much time was therefore lost in repairing the damages done by the sand-blast inside the pump. It was also found that when the material consisted largely of sand a much greater quantity of water had to be pumped in order to keep the sand moving through the pipes; and the water must be driven with greater velocity. Even then there is danger of its accumulating in the discharge-pipes and choking them. This frequently happened when the end of the discharge-pipe was high and at a long distance from the pump. The price paid for dredging and depositing the material on the Flats under this contract is 15.45 cents per cubic yard. It is worthy of note that the sand pumped up from the river and discharged on the back part of the fill, is actually worth, for building purposes, from 50 to 75 cents per cubic yard.

When the third contract was awarded to Benson & McNee it became necessary to build a third machine. This they did, giving her more powerful engines, and adding a few improvements that experience had shown to be expedient.

It was expected that this machine would do certain parts of the work under contract No. 2, for which the other two machines had not sufficient power. The new machine was put to work the latter part of September, 1885, and worked on the Virginia Channel until winter put a stop to operations. On the night of June 19, 1886, she was totally destroyed by fire, inflicting a severe loss on the contractors, and causing a temporary suspension of work under this contract.

Contract No. 3, with Benson & McNee, was for dredging the Virginia Channel below Long Bridge and a portion of the tidal reservoir, 700,000 cubic yards in all, at 15 cents per cubic yard, measured in place. The work was begun in September, 1885, and is now in progress. The dredging in the Virginia Channel is finished, about 500,000 cubic yards having been deposited on the Virginia side of Section III; that of the tidal reservoir, about 200,000 cubic yards, is about one-third done. Unless some unforeseen accident happens, this contract should be completed by the middle of August, 1886. The material from the tidal reservoir is deposited on the Flats adjacent to the Monument grounds.

The following table gives a summary of the work done by each one of the three hydraulic dredges engaged on this improvement:

Summary of work done by each hydraulic dredge engaged in improving the Potomac River near Washington, D. C., during the year commencing July 1, 1885, *and ending June* 30, 1886 (*exclusive of January and February*).

Date.	Dredge No. 1.			Dredge No. 2.			Dredge No. 3.		
	Actual engine hours.	Estimated cubic yards dredged.	Average cubic yards per engine hour.	Actual engine hours.	Estimated cubic yards dredged.	Average cubic yards per engine hour.	Actual engine hours.	Estimated cubic yards dredged.	Average cubic yards per engine hour.
July, 1885	381¾	39, 325	118	338½	94, 157	278	......	....	.....
August, 1885	205	20, 947	102	378	73, 266	194	......	....	.....
September, 1885	231½	38, 271	165	224½	45, 450	202	......	....	.....
October, 1885	453¾	97, 800	216	359	59, 375	165	214	25, 282	118
November, 1885	341¾	62, 282	182	367	60, 159	164	330½	45, 267	137
December, 1885	443	88, 590	200	274	28, 287	103	311½	48, 348	155
March, 1886	342	76, 303	223	303	41, 250	136	405	79, 842	197
April, 1886	374½	60, 049	160	375½	48, 287	129	304½	68, 188	224
May, 1886	214	35, 152	164	364½	50, 685	139	267	58, 017	217
June, 1886	370	72, 442	196	419½	75, 329	180	*182	34, 772	191
Totals	3, 307	591, 131	179	3, 403½	576, 245	169	2, 014½	359, 666	179

*This dredge was burned June 19, after having worked .65 of that month.

NOTE—The number of cubic yards dredged is taken from the inspectors estimates as measured *in situ*, and is somewhat less than the actual amount.

It is to be noted that the endeavor has been to run each machine continuously night and day, except Sundays. The total number of engine hours made in a month is the maximum that each machine was capable of. The remainder of the time was lost in repairs, cleaning boilers, drawing fires, moving machine, taking out obstructions, arranging pontons and pipe joints, and by freshets, ice, wind, &c. Each machine was laid up the greater part of January and February on account of ice, and those two months are not included in the statement. The capacity of each machine depends on the character of the material, the height of discharge, the length of the discharge-pipe, and the velocity at which the pump is run. In soft mud progress is quite rapid. As much as 7,000 and 8,000 cubic yards have been dredged in one day. An average of 400 cubic yards per hour is often attained. In sand progress is slow, and much time is lost in repairs.

The material in the river varies greatly. In some places it consists almost entirely of sand, in others of mud. Then again there are mixtures of each in varying proportions, and strata of varying thickness. The greatest length of discharge-pipe at any time was about 3,500 feet, and the greatest height to which the material was discharged about 10 feet above the level of low tide.

The formation of an embankment along the southeast side of the tidal reservoir, and the outside margin of the fill between the site of the inlet gates and Long Bridge, was in progress at the beginning of the fiscal year. This work was done by hired dredging-machines, and was finished in November, 1885.

One hundred and eleven thousand nine hundred and thirty-five cubic yards of material were dredged and deposited in embankment at a cost to the United States of 8.4 cents per cubic yard. The lowest bid for this work, under proposals advertised for in the usual way, was 16 cents per cubic yard, being very nearly double that at which it was subsequently done by hired labor. The past winter and spring have been noted for the great number of freshets. Though none of them caused a rise in the river at this place higher than about 6½ feet above mean low tide, their frequent recurrence kept up a swift down-stream current, which retarded work and caused an injurious deposit of sediment in the dredged channels. The water of the Potomac, which during the spring and summer is usually quite clear, has been discolored almost continuously with the washings from the upper river. In the Washington Channel there was a fill of no less than 4 feet a short distance below Long Bridge; and in the Virginia Channel above the bridge and immediately below the contracted part of the river, there was a fill of nearly the same amount. It has been necessary thus far in carrying on the work to keep open the Washington Channel to aid in the discharge of freshets; and until the cross-section of the Virginia Channel had been increased, it was thought unsafe to do work on Section II that would materially diminish the freshet discharge across that part of the Flats. The work has now reached that stage of progress when it is not only desirable, but important, to close the upper end of Washington Channel in order to prevent these freshet deposits. As soon as the embankment along the outer margin of Section II is up to a height of 6 feet or more, it is thought the width of the river will be sufficiently contracted to prevent injurious deposits above Long Bridge; and as the Washington Channel will be closed at the upper end, no appreciable amount of sediment will be swept into it.

The recurring freshets not only retarded work and damaged to some extent the dredged channels, but some of the embankments made on Section II, just above Long Bridge, were also damaged. Indeed, we must be prepared to have the work damaged by every freshet until it has progressed further toward completion. Taken altogether, the damage done by the freshets and ice during the past year was comparatively small, and most of it could have been avoided had an adequate appropriation been made in 1885.

During the month of December, 1885, an examination was made of the site of the proposed sluice-gates. Their location will be about 1,200 feet from Long Bridge. Borings were made with an artesian-well tube to a depth of about 70 feet below mean low tide. The soil was found to consist chiefly of mud and sand, in strata of varying thicknesses, with some gravel, the mud strata in some cases being very soft. At a depth of about 70 feet there were indications of rock in close proximity. Further examination was stopped by the very cold weather that set in. The borings showed conclusively that a pile foundation will be necessary for the inlet gates; but an unexpected feature was the discovery of gas under considerable pressure. This gas appeared to be in pockets, and at various depths from about 26 feet to 65 feet below the level of low tide. At 65 feet the pressure was great enough to throw out stones, gravel, and mud to a height of 15 or 20 feet above the top of the pipe. The gas was inflammable, and burned with a clear flame, the flow continuing for some hours after being tapped, the pressure becoming more and more feeble until the gas ceased to flow altogether. It is supposed to be marsh-gas, but further examination will be made.

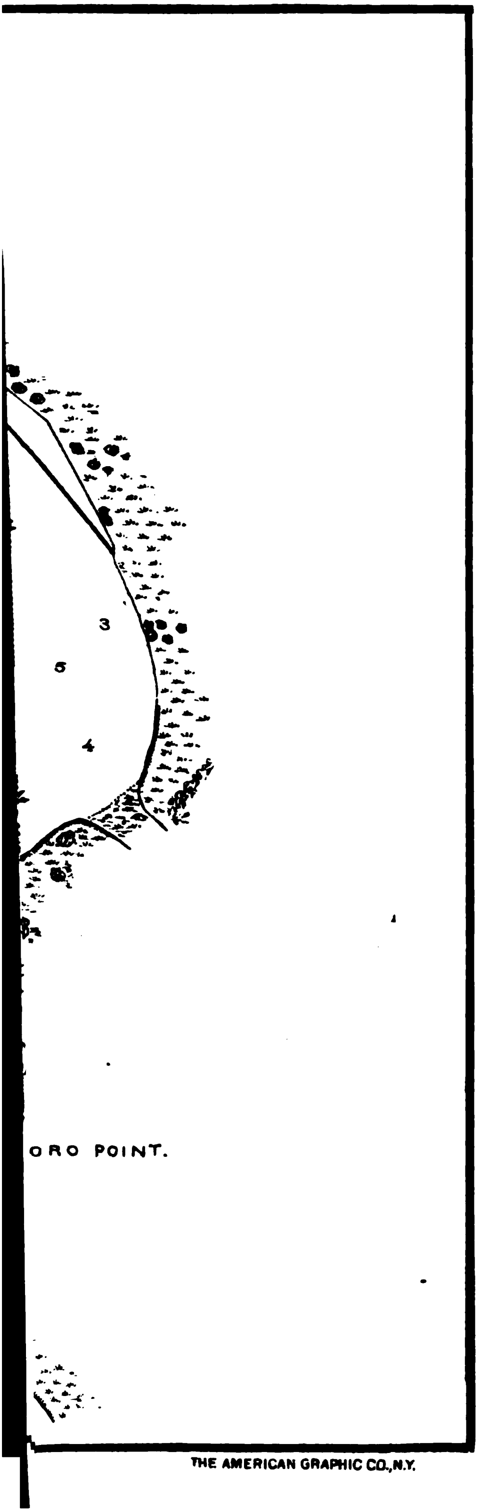
SEWER-CANAL.

The necessity of Congressional action relative to the sewer-canal at the foot of Seventeenth street becomes more and more imperative each year. It will be remembered that one of the largest sewers in the city discharges at this point. Formerly it discharged the sewag Flats, but within a few years a canal has been cut across the Flats, i have from time to time been raised, and the Flats on each side now being filled in. The sewage discharged into this canal is in year by year. The canal is not a proper receptacle for it, as th current in it except that produced by tidal action and the co accretions from the sewer itself. As a consequence, the head canal, and sometimes its entire length (about 3,500 feet), is cov a sickening mass of fœcal matter, the odors from which are f pleasant. A single visit at such times will suffice to give on idea of its present condition. It is sometimes suggested that th should be extended out over the flats and into the river. Thi ceive to be objectionable. It would not remove the present nu it would merely hide it from view. The gases that now emana this mass of corruption would be retained in the sewers to be dist through ventilators into the city, and perhaps largely into d houses. The most satisfactory solution of the problem would s be to close the present end of the sewer and establish a large pump there, to pump the sewage out into the river, or as far a may seem necessary; the closure of the sewer to be made by g open either automatically or otherwise, during a rainfall, the w which would be discharged into the canal. The latter, under s cumstances, would only receive rain-water contaminated by litt age. This was, substantially, the plan recommended by Capt. Greene, Corps of Engineers, United States Army, while assistant Engineer Commissioner of the District. If some such plan sho carried out by the District authorities, it would appear to be but and right for the Government to take care of the canal itself, bu taining-walls to its sides, and establish flushing sluices from th reservoir near its head. An estimate was submitted for conc taining-walls in December, 1882. Their cost will be about $2 and an appropriation of $100,000 is recommended to begin the w their construction.

LONG BRIDGE.

The attention of Congress is again called to the necessity of in regard to Long Bridge. The plan recommended by the Bo Engineers for the improvement of the river front contemplates t building of Long Bridge at an early period during the progress o improvement, with wide spans upon piers affording the least po obstruction to the flow of water. No plan of improvement can be satisfactory while the bridge remains as it is—a serious obstructi the flow of water beneath it. A large amount of riprap stone has time to time been placed around the piers for their protection, an gether with the piers themselves, which are set obliquely to the fr current, form a partial dam across the river, which will always menace to the improvement. The dredging in the Virginia Cha above and below this bridge, has had to be stopped some distance it for fear of injuring the foundations of the piers. The bridge o to be rebuilt without unnecessary delay.

The financial statement shows a balance of $122,237.06 as appar available for work. Practically there is nothing available. All money is needed to meet liabilities to be incurred under existing tracts, and none of it can be applied to any other portion of the w All of it would have been expended before this but for the unfore delays that have occurred in the prosecution of the work. The



THE AMERICAN GRAPHIC CO., N.Y.

has been an unfavorable one for rapid progress, and the contractors for dredging have been unfortunate in losing their best and most powerful dredging machine.

It is of the utmost importance that one large appropriation be promptly made in order that the work may be put in a safer condition. In its present condition it is subject to damage by freshets, ice, and even by high winds, which cause destructive wave action on the unprotected embankments. The prompt expenditure of about $800,000 would be an economical measure. After that smaller appropriations would suffice, if it then be deemed expedient to have the work progress slowly.

With liberal appropriations the improvement can be completed within the estimates, and, when completed, the value of the land reclaimed will be fully equal to the cost of reclamation.

Washington City is in the collection district of Georgetown, D. C. The amount of revenue collected and the commercial statistics are given in the report of the improvement of Washington and Georgetown harbors. Nearest light-house, Jones' Point, Virginia.

Money statement.

July 1, 1885, amount available		$358,027 93
July 1, 1866, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$197,602 12	
July 1, 1886, outstanding liabilities	38,188 75	
		235,790 87
July 1, 1886, amount available		122,237 06
Amount appropriated by act approved August 5, 1886		375,000 00
Amount available for fiscal year ending June 30, 1887		497,237 06
Amount (estimated) required for completion of existing project		1,441,365 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		800,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

Abstract of contracts for improving Potomac River in the vicinity of Washington, D. C., in force during the fiscal year ending June 30, 1886.

No.	Names and addresses of contractors.	Date of contract.	Subject of contract.	Price per cubic yard.
				Cents.
1	Benson & McNee, San Francisco, Cal	Aug. 28, 1884	Dredging	12.87
2	......do	Sept. 29, 1884	....do	15.45
3	......do	Mar. 16, 1885	....do	15
4	G. Vanderwerken, Georgetown, D. C.*	Mar. 16, 1885	Riprap stone	85

*Completed.

I 3.

IMPROVEMENT OF THE JAMES RIVER, VIRGINIA.

The improvement of the James River was regularly undertaken by the Government in 1870. A small sum had been expended previous to 1855 under the direction of Colonel De Russy, Corps of Engineers, United States Army, and was of some advantage to navigation.

The next appropriation was made in 1870, since which time appropriations have been made as follows:

Year.	Amount.	Year.	Amount.	Year.	Amount.
1870	$50,000	1875	$50,000	1881	$60,000
1871	50,000	1876	60,000	1882	75,000
1872	50,000	1878	70,000	1884	75,000
1873	75,000	1879	75,000		
1874	50,000	1880	75,000	Total	815,000

The city authorities of Richmond, Va., have also expended the sum of $444,696.45

The expenditures during the fiscal year ending June 30, 1886, were $16,696.95.

When the improvement was undertaken by the Government navigation was obstructed by sunken vessels, by remains of military bridges, and by obstructions purposely put in the river during the late war to prevent the National fleets from approaching too close to Richmond. There were, besides, natural obstructions.

Rocketts Reef and Richmond Bar had only 7 feet of water at mean low tide; from Warwick Bar (where the depth was 13 feet) to Richmond the channel was crooked and obstructed by dangerous rocks and ledges. The Dutch Gap Cut-off, which now saves 5½ miles of difficult navigation, was not then open.

The original project was to secure a depth of 18 feet at full tide, corresponding to 14.5 feet at low tide, to Richmond, with a channel width of 180 feet from Harrison's Bar to Richmond docks, the excavation in rock to be 18½ feet at full tide. This project was well advanced when Congress, by act approved July 5, 1884, adopted the project of 22 feet at mean low tide from Richmond to the sea. Operations during the past year have been conducted under this project.

In carrying it out a large amount of excavation will be in solid rock, and the cost will necessarily be great. The width to be given to the channel is 400 feet from the sea to City Point, 300 feet from City Point to Drewry's Bluff, and 200 feet from thence to Richmond.

The methods employed for improving the river consist in dredging, rock excavation, and contraction of water-way by means of dikes or jetties.

Owing to the failure of the river and harbor bill of 1885 the operations of the last fiscal year were restricted to an endeavor to maintain the channel existing at the beginning of it. The expenditures were devoted entirely to dredging. The city authorities of Richmond, Va., have also expended the sum of $12,524.47 during this same period; so that $29,221.42 represents the amount expended during the year in maintaining the conditions existing at the beginning of the year. It can hardly be said that this has been fully done, as the depth now is perhaps a fraction of a foot less than it was a year ago, and there still remains a considerable quantity of sand to be removed from the harbor.

The year has been remarkable for the number of high freshets. There were five freshets reaching a height of 16 feet and upward. As a consequence, there has been an immense quantity of sand and silt deposited in the river, which it was necessary to dredge out, or allow it to obstruct navigation. The greater part of the sand and gravel brought down by the freshets lodges in the harbor above and near the ship-locks. Considerable was deposited on Randolph Flats and below, while at Falling

Creek, below the works of contraction, an entirely new shoal was developed. No appreciable deposit of sand appears to have taken place on the section of the river between Gillies Creek and the upper part of Randolph Flats.

Besides the freshets there were two ice-gorges. In one case the ice formed almost a solid mass to the bottom of the river. Several large steamers tried to break it, but failed. Luckily it broke up by a gradual thaw. The ice in the harbor caused a large amount of sand, composing the bar just above the ship-locks, to be washed out and deposited in the channel between the locks and Gillies Creek. This deposit is now being removed by the city authorities at their own expense.

Prior to the first freshet in January, 1886, a channel 18 feet deep at low tide had been made through Randolph Flats Bar, and for some distance below. The subsequent freshets filled up the dredged channel and made it necessary to redredge a part of it. A remarkable feature in connection with the filling at Randolph Flats is a fill that took place between Jetties No. *14 and No. *16. This particular place has been dredged several times before. After the freshet the water was deeper outside the cut than in it. Evidently there is some local cause for this, and it will be investigated. At Falling Creek, just below the works of contraction, a new shoal made its appearance immediately after the subsidence of the January freshet. The depth had decreased to about 12½ feet at mean low tide. In dredging a cut through this shoal the remains of an old military bridge were found, built on cribs filled with stone. There were removed from the cut 29,600 cubic yards of sand, 290 cubic yards of rock (used for sinking cribs of bridge), and 122 logs.

In dredging Randolph Flats there were removed 92,720 cubic yards of sand and 950 cubic yards of gravel.

During the month of May an examination was made of the dredged cut through Swan Point Shoal. As stated in my last annual report, it was expected that, on account of the local characteristics of the river at this place, a dredged channel would be permanent without works of contraction. It was found that the cut, made more than a year ago, had not only maintained itself, but that it had considerably deepened. The exact increase of depth has not been determined, as no regular survey has yet been made.

The experience of the past year has demonstrated what was stated in the last annual report, viz, that an annual expenditure will be required to maintain the river in navigable condition after it has been improved. This arises from the fact that the freshets bring down immense quantities of solid material, which is deposited in the bed of the river whenever the current is too sluggish to keep it moving. If the appropriation made by act of July 5, 1884, had all been expended on June 30, 1885, the navigable depth to Richmond would have been reduced to 12 feet, or less, at mean low tide.

The channels, as a rule, where the works of contraction have been well advanced, maintain themselves; the most of the deposits takes place above and below these works. Such was the case the past year. The deposit of sand above Gillies Creek was immense. The deposit at and near Falling Creek has been going on for several years, and was not so great. At Randolph Flats, where the works of contraction are well advanced, the deposit was not great, though the dredged channel was obliterated. The cross-section of the river was rather increased, though the available depth was reduced. At other points above Randolph Flats the deposit was not large, but is supposed to be due largely to the lodgment of snags, wrecks, &c., which quickly cause a shoal to form around them. Unless they be promptly removed, they obstruct navigation.

The disposal of spoils in dredging the upper part of the James River is fast becoming a serious problem. The areas between the spur-dikes, built to contract the stream have heretofore been the dumping-ground for all dredgings, and they have been of great value. These spaces, however, are now becoming filled up, so that dumping scows of the lightest draught can only get in at high-tide, and in many places cannot get in at all. It is necessary to find new dumping-grounds, or the material must be transported in some other way. The latter is doubtless the better plan, particularly as the time approaches for connecting the ends of the jetties by longitudinal training-dikes. When this is done the spaces referred to will be closed in.

The present condition of the improvement may be stated as follows: There is 19½ feet of water at full tide (17½ feet at low tide) from the sea to Kingsland's Reach; 18 feet at full tide (14.5 feet at low tide) from thence to Randolph Flats, and about 17 feet (13.5 at low tide) from thence to Richmond.

There has been expended on the new project, the estimate for which is $4,500,000, the sum of $94,673.33.

To make reasonable progress in an undertaking of this magnitude large annual appropriations will be necessary. A sum estimated from $15,000 to $30,000 will be needed annually to remove the deposits of freshets. Four hundred thousand dollars, therefore, would seem to be a moderate sum to apply in execution of this project. This amount could be profitably expended in the fiscal year 1888.

Money statement.

July 1, 1885, amount available	$19,256 22
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	16,696 95
July 1, 1886, amount available	2,559 27
Amount appropriated by act approved August 5, 1886	112,500 00
Amount available for fiscal year ending June 30, 1887	115,059 27
Amount (estimated) required for completion of existing project	4,273,570 45
Amount that can be profitably expended in fiscal year ending June 30, 1888	400,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

Table showing freshets in the James River, Virginia, and the heights to which they rose at Richmond.

Date.	Height above mean low water.	Date.	Height above mean low water.
	Feet.		*Feet.*
Unknown	13.30	January 17, 1877	10.50
Do	13.05	April 10, 1877	6.90
Do	12.65	October 5, 1877	13.83
1847	16.50	November 9, 1877	11.00
1863	16.79	November 25, 1877	28.62
1864 (?)	16.10	January 15, 1878	8.85
October 1, 1870	27.02	February 11, 1878	7.30
February 26, 1875	14.38	April 11, 1878	5.50
December 9, 1875	5.60	May 7, 1878	6.26
March 30, 1876	12.00	May 16, 1878	6.80
September 24, 1876	12.19	September 15, 1878	13.38

Table showing freshets in the James River, Virginia, &c.—Continued.

Date.	Height above mean low water.	Date.	Height above mean low water.
	Feet.		*Feet.*
November 18, 1878	12.75	January 7, 1884	7.70
December 12, 1878	12.62	February 11, 1884	10.50
January 16, 1879	7.80	March 11, 1884	13.70
December 15, 1879	9.82	March 27, 1884	15.70
February 15, 1880	6.76	June 15, 1884	8.40
March 15, 1880	13.32	June 28, 1884	9.30
May 2, 1880	6.90	May 28, 1885	9.90
January 22, 1881	10.40	October 31, 1885	15.90
February 13, 1881	12.95	January 7, 1886	15.10
December 27, 1881	10.50	February 14, 1886	12.70
February 11, 1882	11.00	April 2, 1886	24.30
January 21, 1883	9.70	April 8, 1886	17.00
April 18, 1883	9.70	May 9, 1886	16.30
April 26, 1883	8.80		

COMMERCIAL STATISTICS FOR FISCAL YEAR ENDING JUNE 30, 1886.

Value of domestic exports	$2,471,213 00
Custom-house receipts from all sources	10,635 79
Number of vessels entered from foreign ports	26
Number of vessels cleared to foreign ports	70
Number of vessels entered from domestic ports	547
Number of vessels cleared to domestic ports	455

HARBOR-MASTER'S STATEMENT.

Number of vessels, with amount of tonnage, arriving at the port of Richmond, Va., during the fiscal year ending June 30, 1886.

	Number.	Tonnage.
Barks	23	....
Brigs	29	....
Schooners	530	200,000
Steamers	290	550,000
Total	872	750,000

NOTE.—The above table does not include river or bay vessels, tugs, or river steamers.

I 4.

IMPROVEMENT OF SHENANDOAH RIVER, WEST VIRGINIA.

Congress, by act of June 14, 1880, made an appropriation of $15,000 for improving the Shenandoah River, West Virginia. By act of March 3, 1881, an additional appropriation of $2,500 was made for the same object. A proviso was added to the latter act, to the effect that neither of these appropriations shall be expended "until any corporate rights or franchises that may exist over said river shall have been relinquished to the United States to the satisfaction of the Secretary of War." This condition has been complied with.

The project for the improvement is to rebuild the locks, dams, and chutes of the old Navigation Company, so as to secure a down-stream navigation of about 18 inches. No work has been done, however, as further legislation of Congress has been asked.

Money statement.

July 1, 1885, amount available	$16,083 40
July 1, 1886, amount available	16,083 40

PLANS FOR CONSTRUCTION OF BRIDGE ACROSS THE POTOMAC RIVER.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., June 23, 1886.

SIR: I have the honor to return herewith the resolution of the Senate of the United States of the 24th ultimo, which was referred to this office for report, directing the Secretary of War to "examine and report upon the expediency of constructing a Government bridge, with a suitable draw and approaches, from a point at or near the foot of New York or New Hampshire avenue, on the public grounds, across the Potomac River and Analostan Island to a point on the United States national cemetery grounds at Arlington," with estimate of cost, &c., "as well as the cost of alternative plans," &c., and to submit the inclosed copy of the report thereon of Maj. Peter C. Hains, Corps of Engineers, dated the 21st instant, to which attention is invited.

Major Hains has given the subject such consideration as the limited time and means at his disposal would permit, and his views, clearly and succinctly stated, are entitled to consideration. The plans he submits are for draw-bridges only, and he is of opinion that "a bridge somewhat ornamental in design, with a wide draw, built on stone piers, with wide spans, so as to allow ample area for the discharge of freshets, would seem to meet all actual wants." He estimates the cost of the bridge he would propose, viz, "an iron truss with four spans of about 300 feet each, the second span from the Washington City side to be a pivot draw," &c., at $609,543. An alternative span with three spans built of steel, draw-span 350 feet, other plans, 425 feet each, would, he thinks, cost about $650,000.

In connection with this subject, and having reference to the clause of the resolution relative to alternative plans, I have to submit the inclosed copy of a communication to this office, dated June 7, 1886, from Capt. Thomas W. Symons, Corps of Engineers, submitting a design for a bridge "from Observatory Hill to Arlington, across the Potomac River," which, it will be observed, is a high bridge of an ornamental as well as monumental character. It does not appear that Captain Symons has allowed sufficient head room. He estimates the cost of a bridge designed as shown in the drawings accompanying his communication at from $1,000,000 to $1,500,000.

It may be added that the limited time given for so important a subject rendered it impracticable to give more than a casual study of the question.

The proposed structure, whether viewed from a local or a national standpoint, would involve interests of such magnitude and importance as to demand, in my judgment, the careful consideration of a mixed Board of Engineers, whose duty it should be to give the plans to be adopted for its construction the fullest and most careful consideration, and it is recommended, should Congress provide for its construction, that such a Board be authorized.

Very respectfully, your obedient servant,

JOHN NEWTON,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

Hon. WM. C. ENDICOTT,
Secretary of War.

REPORT OF MAJOR PETER C. HAINS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., June 21, 1886.

SIR: The following resolution of the Senate was referred to me, by indorsement of the Chief of Engineers, Unites States Army, fcr report:

> IN THE SENATE OF THE UNITED STATES,
> *May* 24, 1886.
>
> *Resolved,* That the Secretary of War be directed to examine and report upon the expediency of constructing a Government bridge, with a suitable draw and approaches, from a point at or near the foot of New York or New Hampshire avenue, on the public grounds, across the Potomac River and Analostan Island, to a point on the United States national cemetery grounds at Arlington, so as to connect, in the best manner, the public grounds on the two sides of the Potomac, with estimates of the cost of the kind of bridge deemed by the Department most expedient, as well as the cost of alternative plans considered practicable, and which will not materially affect the navigation of the river.
>
> Attest:
>
> ANSON G. MCCOOK,
> *Secretary.*

The expediency of constructing such a bridge as the resolution calls for has been discussed for several years without apparently developing a dissenting opinion. Indeed, no argument is needed to show the expediency of a bridge of some kind other than a glance at the map* of Washington and Georgetown harbors, transmitted herewith. The filling of the Potomac Flats will reclaim an area of about 750 acres of land along the river front on the Washington side. From the Capitol to the Monument Grounds there is already an area of 373 acres of public land laid out in parking, to which the reclaimed Flats will be connected. A bridge from the latter to Arlington will connect the whole system. Arlington Cemetery, where the remains of so many gallant soldiers of the Union rest, is a place of resort of the majority of visitors to the national capital, and would be to many people of the District if there were better facilities for reaching it. The route by way of Long Bridge is so long that it is almost impracticable to pedestrians. It is unsafe for carriages drawn by spirited horses, and is too narrow to afford proper facilities. The route by way of the Aqueduct is but little better, and in its present condition less safe; besides it is not a Government bridge, and annoying tolls are exacted from every one crossing it. A short line of communication that would be available to pedestrians as well as for those who ride is very desirable. The shortest and least expensive route is that indicated on the accompanying chart. This line is almost a direct prolongation of New York avenue, and would place the bridge about midway between the Aqueduct and Long Bridge; so that whether the

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* Omitted.

Aqueduct be made a free bridge or not, this would be a desirable improvement.

The only question is, What shall be the character of the bridge? There is no limit to the number of different kinds of bridges that are practicable, and that will not materially affect the navigation of the river. A bridge somewhat ornamental in design, with a wide draw, built on stone piers, with wide spans, so as to allow ample area for the discharge of freshets, would seem to meet all actual wants.

Such a structure would cost comparatively a small sum of money; but, if the bridge be designed as a monumental structure, it can only be done at considerable increase of cost.

I have had made an accurate cross-section of the river bed along the line of the proposed bridge, and a number of borings to determine the depth to solid rock. These are indicated on the accompanying tracing. The depth to rock, from the surface, varies, as will be seen, from 28 to 42 feet. The conditions are, therefore, favorable for the erection of a heavy structure.

The plan of the bridge that I would propose, is that of an iron truss, with four spans of about 300 feet each; the second span from the Washington City side to be a pivot draw (see sketch* herewith.) The draw will thus be in the deepest water, easy of access, and directly in the channel-way of the river. The bridge to have carriage-way 24 feet wide, and two sidewalks, each 8 feet wide. The main bridge structure will be about 1,200 feet long. The approach on the Washington side to be by a wide roadway on an embankment with a grade of about 3 feet in 100. Analostan Island and the bed of Little River should be crossed partly by an embankment and partly by open trestle supporting the roadway, the proportion of embankment and trestle work to be so calculated as to give an open area sufficient, in addition to the area in the main river, to discharge the highest freshets.

The lower chord of the bridge should be placed at about 28 feet above the level of low tide; this would allow tugs and small craft to pass under the bridge without opening the draw. The piers and abutments to be built in the most substantial manner of solid masonry; the truss to be capable of bearing a moving load of about 75 pounds to the square foot of roadway.

A bridge of this kind will, in my opinion, best fulfill the requirements of the Senate resolution, viz:

> A Government bridge, with a suitable draw and approaches, so as to connect in the best manner the public grounds on the two sides of the Potomac.

The cost of such a structure, finished in the best manner and with some degree of ornamentation, it is estimated, would be as follows:

Two abutments and approaches, including excavation, coffer-dam, pumping, &c	$96,280
Three channel piers, including excavation, coffer-dam, leveling rock to receive foundation courses, &c	199,800
Draw-pier	51,000
Two guard-piers	85,800
Pile and timber connections	5,000
Three truss spans, including erection of false works, &c., at $35,000 each	105,000
One draw-span	40,000
300 feet (linear) iron trestle bridge across Analostan Island	30,000
125,000 cubic yards embankment, at 25 cents per cubic yard	31,250
Contingent and office expenses, &c	55,413
	609,543

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*Omitted.

The cost of the bridge could be reduced by increasing the number and reducing the width of the spans, but such reduction would not be expedient, as it is important to keep the number of piers down to the minimum, in order not to obstruct the flow of water.

A variation in the form of truss could be made by curving the upper chord, and to some this modification would have a more pleasing effect. The cost would be practically the same.

An alternative plan would be a three-span truss, built of steel, and with the upper chord either curved or straight. The draw span, in this case, to be about 350 feet. The other two spans, about 425 feet each. In other respects, the bridge would be like the four span structure already referred to. It would have one great disadvantage, however, as the draw-span would be located partly in shoal water, so that vessels, as a rule, would use only the side toward the Washington shore.

The cost of a three-span bridge would be about $650,000.

The resolution of the Senate calls for the cost of alternative plans considered practicable, and which will not materially interfere with navigation. There are many plans of high bridges entirely practicable, which will not interfere with navigation, but it will take several weeks at least to prepare even a few such plans, with reliable estimates of cost, and as this report is wanted immediately, no attempt will be made to do so.

There may be a great diversity of opinion as to the height necessary to build a bridge, in order that it may not *materially* interfere with navigation. If navigation interests alone were consulted, a clear height of at least 140 feet would be considered necessary. In these days of sharp competition, every obstacle to free navigation in any port tends to drive trade to other outlets. To require all or nearly all sailing vessels that trade to Georgetown to lower their topmasts, for instance, would be regarded as a great hardship by their owners. To build a bridge high enough for them to go under without so doing would add immensely to the cost of the structure. It must not be forgotten that the Government has at great expense improved the channel approaches to Georgetown, so that larger vessels can now reach it. Is it good policy to interpose what would be considered a serious obstacle of another kind? Ordinary trading schooners have their topmasts rigged so that they can be taken down and replaced with facility.

A bridge, then, if built without a draw, would need to be about 140 feet above high tide. To construct such a bridge, whether it be a suspension, a cantilever, or arched bridge, would be an expensive undertaking the cost running up into the millions.

Very respectfully, your obedient servant,

PETER C. HAINS,
Major of Engineers,
Bvt. Lieut. Col., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

LETTER OF CAPTAIN THOMAS W. SYMONS, CORPS OF ENGINEERS.

WASHINGTON, D. C., *June* 7, 1886.

GENERAL: I have been for some time specially interested in the subject of a bridge from Observatory Hill to Arlington across the Potomac River.

I have designed a bridge for this location, and I have the honor to send you herewith sketches and a general description of it, together with an approximate estimate of its cost.

The bridge is designed to furnish a wide travel-way from the capital to the national cemetery and extensive Government estate at Arlington, to pass at a sufficient height above the river to incommode commerce in the least possible manner, to be monumental in its character, artistic in all its details, and pleasing in general effect.

The main idea to be conveyed by the bridge is embodied in the general description sent herewith—that it is a monument to Lincoln and Grant.

It seems peculiarly fitting that the nation's monument to these great men should take the form of a noble bridge across the river which separates the two sections lately in arms against one another. It is symbolical of the renewed Union brought about so largely by their genius, wisdom, and strength.

A subordinate idea of the bridge is to provide fit places for memorial statues to the lieutenants of Lincoln and Grant who were active and influential in the council chamber and the field during the civil war.

The places provided are upon the piers of the bridge on each side of the roadway, and as indicated on the blue print and tracing sent herewith. These details could be modified for each pier and a pleasing variety of effect produced.

The location of the bridge is on the direct line from the Naval Observatory to the northern gate of Arlington.

The main spans are 306 feet in the clear, with a clear height above high tide of 90 feet under two of them. This is believed sufficient for all purposes. Some of the largest vessels going to Georgetown would have to lower their topmasts to pass under, but on the whole the inconvenience resulting would be very much less than that from a low bridge with a draw; besides, the monumental character of the bridge requires it to be continuous and precludes the adoption of a draw.

The arches are designed to be of steel specially adapted for the work. In the drawings these are shown as segment arches. It would probably be more desirable to adopt the elliptical form, as more graceful and more suitable under all the circumstances. The approaches and a portion of the bridge across the lowlands are designed to be in embankment 50 feet in width on top, well paved, and with sidewalks and a substantial railing. The side slopes to be 1 on 1½.

Cost of the bridge.—It is only possible to estimate approximately the cost of this bridge. To make a close estimate would require much more elaboration of the design and much more data than are now available as to the subriver strata. The accompanying estimate is made upon data obtained from various sources and assumed according to my best judgment. According to the estimate, the cost would be $1,250,000.

This would give a bridge of great strength and solidity, of the highest excellence, and in every way a suitable structure. It does not include anything in the way of statuary, which could be added from time to time.

The plans and estimates can be modified in such ways as to provide for a bridge of the same general type at an expense not exceeding $1,000,000.

On the other hand, unknown difficulties of construction, increased ornamentation, beautification of the approaches and their vicinity, &c., might bring the cost up to $1,500,000.

In other words, the bridge will cost from $1,000,000 to $1,500,000, according to the ultimate details adopted and the difficulties of construction met with.

By deflecting the bridge from the direct line to the gate of Arlington, so that it shall cross Analostan Island proper, a saving could be effected of $150,000 to $200,000.

I have the honor to request that this design may be considered as one of the alternative designs asked for in Senator Sherman's resolution.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

ESTIMATE.

Embankment, 600,000 cubic yards, at 25 cents	$150,000
Macadam pavement on embankment	3,500
Railing along embankment	1,500
Two abutment piers, each 3,000 cubic yards, at $12.50, $37,500	75,000
Five small piers, each 750 cubic yards, at $12.59, $9,375	46,875
Three channel piers, each 5,600 cubic yards, at $15, $84,000	252,000
Two piers, each 5,600 cubic yards, at $12.50, $70,000	140,000
Two piers (Analostan), each 750 cubic yards, at $12.50, $9,875	18,750
Four steel spans, 300 feet clear, each 1,250,000 pounds, at 5 cents, $62,500	250,000
Seven steel spans, 150 feet clear, each 300,000 pounds, at 5 cents, $15,000	105,000
One steel span, 200 feet clear, 500,000 pounds, at 5 cents	25,000
Roadway and sidewalks	30,000
Railing on bridge proper	6,000
Riprap protection to embankment	6,000
Wing-walls	15,000
All other expenses, including engineering, surveying, painting, lighting, testing materials, office expenses, &c., and contingencies	125,375
Total	1,250,000

DESIGN FOR BRIDGE ACROSS THE POTOMAC RIVER FROM OBSERVATORY HILL TO ARLINGTON.

General description.

Superstructure.—Bridge to be essentially a deck bridge, with two partially through spans. Roadway to be 30 feet wide, with 8 feet sidewalks on each side. Roadway to start in Observatory Grounds, at an elevation of 40 feet above tide, and gain an elevation of 95 feet over the two center spans, then to descend at the same grade one foot in 35 feet, or $2\frac{86}{100}$ feet in 100 feet, to an elevation of 40 feet at Analostan slough, and then ascend to an elevation of 60 feet at Arlington gate. Roadway to be supported by by steel arches across the main river, Potomac Park, and a part of the low lands of Analostan Island.

A truss bridge across Analostan slough; the remainder of the way and the approaches to be in embankment.

Spans.—The four spans across main river to be 300 feet wide in the clear. The two center spans to have a clear way above tide of 90 feet, the others a clear way of 70 feet. The seven smaller spans to be 150 feet in clear width, and of varying height, to give requisite grade.

The truss bridge across Analostan slough to be 200 feet span.

Piers.—To be handsome in design, of solid masonry. The ends of the piers outside the superstructure to be brought up to a height of about 8 feet above the roadway, and finished for the reception of memorial statues to the great civilians, sailors, and soldiers active in the civil war. These statues to be added from time to time.

Memorial arch.—A grand memorial arch or other suitable structure to be erected at the Washington end of the bridge, commemorative of Lincoln and Grant, with tablets reciting their great services, and the fact that this bridge across the Potomac from the North to the South is erected as their most suitable monument.

APPENDIX J.

IMPROVEMENT OF THE HARBORS AT BRETON BAY AND SAINT JEROME'S CREEK, MARYLAND; OF THE CHANNEL AT MOUNT VERNON; OF RAPPAHANNOCK RIVER, AND YORK RIVER, VIRGINIA; OF TRIBUTARIES OF THE LOWER POTOMAC, AND OF CERTAIN RIVERS IN VIRGINIA AND NORTH CAROLINA.

REPORT OF MR. S. T. ABERT, UNITED STATES AGENT, IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Channel at Mount Vernon, Virginia.
2. Neabsco Creek, Virginia.
3. Breton Bay, Leonardtown, Md.
4. Nomini Creek, Virginia.
5. Harbor at entrance of Saint Jerome's Creek, Maryland.
6. Rappahannock River, Virginia.
7. Totusky River, Virginia.
8. Urbana Creek, Virginia.
9. Mattaponi River, Virginia.
10. Pamunky River, Virginia.
11. York River, Virginia.
12. Chickahominy River, Virginia.
13. } Staunton River, Virginia.
14. }
15. Dan River, between Madison, N. C., and Danville, Va.
16. Roanoke River, North Carolina.
17. French Broad River, North Carolina.

EXAMINATION.

18. Aqueduct Bridge over the Potomac at Georgetown, District of Columbia.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., July 23, 1886.

GENERAL: I have the honor to submit herewith my annual report for the fiscal year ending June 30, 1886, relating to the improvement of rivers and harbors under my charge.

Very respectfully, your obedient servant,

S. T. ABERT,
United States Agent.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

J 1.

IMPROVEMENT OF POTOMAC RIVER AT MOUNT VERNON, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A history of operations will be found in the Report of the Chief of Engineers for the year 1882, page 1,003.

(2) *Description of original condition.*—The landing at the wharf was formerly made by passing over the flat bordering the channel of the

Potomac for a distance of 1,900 feet. The least depth at that time was 4 feet at low water.

(3) *Plan of improvement.*—The proposed cut to the wharf was intended to have a width of 150 feet and a navigable depth of 6 to 7 feet, with a basin at the wharf of 150 feet radius.

(4) *Results obtained.*—The channel was completed September 1, 1881, with a width of 145 feet and a depth of from 7 to 9 feet. In 1880 and 1881, 41,384 cubic yards of material were removed at rates varying from 12½ to 17 cents per cubic yard.

(5) *Operations proposed.*—No recent examination has been made, but it is believed that $5,500 will be required for the purpose of enlarging and deepening the basin, widening the channel, and removing the silt which has been deposited in the cut.

The following appropriations have been made:

March 3, 1879	$4,000
June 14, 1880	3,000
March 3, 1881	1,500
Total	8,500

Money statement.

July 1, 1885, amount available	$57 14
July 1, 1886, amount available	57 14
Amount (estimated) required for completion of existing project	5,500
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,500
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

STATISTICS OF TRADE.

Mr. Harrison H. Dodge, superintendent, reports the trade by water as follows:

Number of visitors during 1885	20,000
Total value of material products (consisting of dairy products (milk), lumber, grain, sheep, lambs, calves, etc.)	$7,200
Total value of manufactures (consisting of fertilizers, corn-meal, wagons, and carriages, etc.)	3,400
Total	10,600

There were 250 arrivals and the same number of departures of steam vessels during the year, with a greatest draught of 4½ feet.

Mr. Dodge adds:

"The resources of the tributary country are likely to increase perceptibly, owing to a more careful and improved method in the treatment of land and stock. The dairy business grows steadily as the city demand increases.

"Should the facilities be improved the trade by water from this landing would be nearly double the present rate.

"The channel is so narrow and shallow as to permit of boats of the very lightest draught only entering. With great difficulty the steamer can barely make her turn at the pier, oftentimes, however, narrowly escaping being stuck fast in the mud.

"The roughness of this statement I trust may be overlooked, but I must add my prayer that the water approach and exit at Mount Vernon may be speedily improved.

"HARRISON H. DODGE."

J 2.

IMPROVEMENT OF NEABSCO CREEK, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—The report of the survey will be found in the Report of the Chief of Engineers for 1881, page 947. For history of operations, see page 1006, Report of the Chief of Engineers for the year 1882, Part I.

(2) *Description of original condition.*—See Report for 1885, page 963.

(3) *Plan of improvement.*—According to the original project of improvement, the channel was to be 100 feet wide and 7 feet deep at low water.

(4) *Amount expended and results obtained.*—The first and last appropriation was in 1881 ($5,000), which was expended in the manner explained in full in the Annual Report for 1885, pages 962, 963. Nothing done during the year.

Should the improvement be continued, $20,000 should be appropriated for the year ending June 30, 1888.

Money statement.

July 1, 1885, amount available	$57 27
July 1, 1886, amount available	57 27
Amount (estimated) required for completion of existing project	20,000
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

J 3.

IMPROVEMENT OF BRETON BAY, LEONARDTOWN, MARYLAND.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A history of operations will be found in the Report of the Chief of Engineers for the year 1882, page 1009, and in the Report for 1883, page 797.

(2) *Description of original condition.*—Breton Bay enters the Potomac River 82 miles below Washington, D. C. For a distance of 3,600 feet its general course from Leonardtown is southeast. There it changes to southwest, and terminates, at a distance of 6¼ miles from the town, at the 18-foot curve in the Potomac. Its width at Leonardtown is about 550 feet. One and a fourth miles below the width is 1,550 feet, and after further widening it contracts at the mouth to about 1 mile. Its least depth is 8.8 feet near Leonardtown, which gradually increases to 18 feet at the mouth. Before improvement the bar extended from Leonardtown to the 9-foot curve in the bay, a distance of about 1 mile The least depth on it was 5 feet at low water.

(3) *Plan of improvement.*—The original project contemplated dredging a channel 150 feet wide from Leonardtown to the 9-foot curve, with a depth of 9 feet at low water. A basin was to be dredged at the Leonardtown wharf.

(4) *Amended project.*—In order to maintain the depth of water in the channel, I would propose to widen the cut to 200 feet for a distance of 1½ miles, and to enlarge the basin to a width of 400 feet by 800 feet in length. So far as it may be permitted I would deposit the material par-

allel with the channel, as above described. The basin and channel should not be less than 10 feet in depth.

The following are the items of the estimate:

143,000 cubic yards, at 15 cents per cubic yard	$21,450
20 per cent. for contingencies	4,290
Total	25,740

This work can be completed for the sum of $26,000, if appropriated in one year.

(5) *Results obtained.*—At the close of the work, in January, 1885, the channel was 115 feet wide, and not less than 8.8 feet deep. It was found after examination that the basin had decreased in depth at the upper end, and that the channel below the wharf had also decreased in depth for a distance of 2,800 feet. The decreased depth of the basin and of the channel below does not seem to have the same cause. The basin appears to have been filled by the wash from the creeks and banks above it, while the channel below seems to have been much injured by the injudicious management of the steamers. Both these effects may be reduced, but it seems impossible to remove the cause.

No funds were available for the prosecution of the work during the year ending June 30, 1886.

(6) *Amount expended.*—From the year 1879 to June 30, 1886, $22,950.49 have been expended in excavating 131,358 cubic yards of material, at rates varying from 12 to 18 cents per cubic yard.

The following appropriations have been made:

June 18, 1878	$5,000
March 3, 1879	4,000
June 14, 1880	3,000
March 3, 1881	3,000
August 2, 1882	5,000
July 5, 1884	3,000
Total	23,000

The work is in the collection district of Annapolis, which is the nearest port of entry. The work is in the fifth light-house district, and the nearest light-house is Blakistone Island Light.

Leonardtown is one of the landings of the Potomac River boats.

Money statement.

July 1, 1885, amount available	$49 51
July 1, 1886, amount available	49 51
Amount appropriated by act approved August 5, 1886	6,500 00
Amount available for fiscal year ending June 30, 1887	6,549 51
Amount (estimated) required for completion of existing project	19,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	19,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

STATISTICS OF TRADE.

Mr. H. F. Moore furnished a statement of the trade at Leonardtown for 1885, showing the following totals:

Total value of natural products	$338,100
Total value of manufactures	331,000
Total	669,100

For detailed statement see Report for 1885.

Mr. Moore states that a corporation contemplates building a fertilizer factory, and also a factory for the manufacture of hats.

J 4.

IMPROVEMENT OF NOMINI CREEK, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—The report of the final survey will be found in the Report of the Chief of Engineers for 1873, page 822. The report of survey from the ferry (Nomini Wharf) to the head of tide-water, at Beale's Mill, will be found in the Report for 1881, page 954. For history of operations to June 30, 1884, see Reports from 1882 to 1884.

(2) *Description of original condition.*—For full statement of condition before improvement, see Report for 1885, page 966.

(3) *Plan of improvement.*—The improvement proposed in the original project was to dredge a channel 100 feet wide and 9 feet deep at low water from the 9-foot curve in Nomini Bay to White Oak Point, a distance of 4,400 feet. The large increase of trade which followed the opening of the new channel called for an amended project, which was submitted in 1882. The amendment consisted in the proposed widening of the main channel, and in cutting a tributary channel from Bushfield Bay (on the right) in an oblique direction to the main channel. As supplementary to this cut, the closing of the old channel from the same bay was proposed. The old side channel is objectionable for two reasons: It causes the extension of White Point, which encroaches more each year upon the main channel, and it conducts a strong ebb current, which impinges on the bows of the entering steamers and forces them into the shoal water on the opposite side. The widening of the main channel is necessary for the safe navigation of the steamers from Baltimore and Washington. The total cost of the project, original and amended, was $62,500. In the Report for 1885, $30,000 were thought to be sufficient to complete the project.

(4) *Results obtained.*—Thirty-two thousand five hundred dollars have been expended in dredging 74,874 cubic yards of sand and shells, which resulted in securing a channel about 100 feet wide and 9 feet deep from the 9-foot curve in Nomini Bay to White Oak Point, a distance of 4,400 feet. Steamers now trade where formerly only small vessels drawing about 3 feet of water could reach at high tide.

(5) *Work during the fiscal year ending June* 30, 1886.—Nothing was done during the year, the total amount of appropriations, $32,500 (from 1873 to 1882) having been expended.

(6) *Operations contemplated.*—It is proposed to complete the work according to the project submitted in 1882 and described above, namely, to widen the cut to 200 feet for a distance of 5,700 feet from the 9-foot curve in Nomini Bay to Hickory Point.

No work can be done during the year ending June 30, 1887, because no appropriation has been made for this important improvement since 1882.

(7) *Appropriations.*—Thirty-two thousand five hundred dollars have been appropriated and expended between March 3, 1873, and August 2, 1882.

The work is in the collection district of Tappahannock, which is the nearest port of entry.

Money statement.

Amount (estimated) required for completion of existing project........	$30,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

STATISTICS OF TRADE.

Mr. C. W. Ridley, manager of the Washington Steamboat Company, says th landings in Nomini Creek are the most important made by the Potomac River

He gives the total trade by steamers of his company, compiled from actual acc valued at $305,566.

Mr. A. Needham, of the Potomac Transportation Line, reports a total tonna 377 tons.

Mr. F. E. Tubman reports the total value of the trade by sail vessels only $29

J 5.

IMPROVEMENT OF HARBOR AT ENTRANCE OF SAINT JEROME'S CRE MARYLAND.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A report and estimate will be found in Report of the Chief of Engineers for 1881, Part I, page 935. The ports from 1881 to 1886 give the work done since that date.

(2) *Description of original condition.*—Saint Jerome's Creek lies wh in Saint Mary's County, Maryland, and enters Chesapeake Bay 6 m north of Point Lookout and 91 miles south of Baltimore. It is formed two prongs or branches, a south prong and a north prong. The la has a depth varying from 15 feet at the mouth to 6 feet 1½ miles furt up. The average depth in the small channel, which connects the po used by the Fish Commission for experiments in hatching oysters, w before improvement, about half a foot at low water. A bar at the mou between the 9-foot curve in the bay and Corsey's Point, had a length 2,193 feet, and a minimum depth of 2.8 feet at low water. The banks low, the land level and sandy.

(3) *Plan of improvement.*—The original project contemplated dredgi a continuous channel through the bar and into the south prong as f as the "hatching pond." For convenience of description, this chan was divided into an outer and an inner channel, the dividing line bei at the mouth of the creek at Corsey's Point.

First. The outer channel when completed will have a bottom wid of 100 feet, with a depth of 9 feet at low water. Its length will be 2,1 feet.

Second. The inner channel when completed will have a bottom wid of 40 feet, with a depth of 6 feet at low water. Its length from Corsey Point to the upper wharf of the Fish Commission, near the office, will 3,742 feet.

(4) *Amount expended and results obtained.*—The cost of the work u to June 30, 1885, was $20,289.37. The inner channel had a depth var ing from 3.3 to 5½ feet between Deep Point and the upper wharf of th Fish Commission. Its width was about 30 feet.

The outer channel at the close of the year 1884 had a minimum dept of 3.8 feet at low water. At the close of the fiscal year ended June 30 1885, it had a minimum depth of 7.9 feet at low water (in a width of 6 feet) between the 9-foot curve and Corsey's Point. With careful pilotag 8 feet could be carried into the mouth of the creek. From Corsey' Point to Deep Point the depth varied from 6½ to 9 feet at low water. The work, particularly on the outer bar, has always been regarded as ex-

perimental. The preservation of the depth is doubtful, for reasons which have been stated in former reports.

(5) *Work done during the fiscal year ending June* 30, 1886.—All work on this creek is done by dredging under contract. The contract entered into on December 18, 1884, with James Caler & Son, of Norfolk, Va., the lowest bidder, at 13 cents per cubic yard, was continued into the present fiscal year.

	Cubic yards.
The material dredged by Caler & Son up to June 30, 1886, amounted to	63,337
Less deductions for excess over depth specified	277
Net amount of dredging	63,060
Amount dredged to June 30, 1885	51,954
Amount dredged to August 18, 1886	11,106

(6) *Future operations.*—The outer channel has not the depth required by the project, but if it is found to be sufficient for the purposes of navigation, operations under the next appropriation may be limited to securing in the inner channel the depth and width desired by the Fish Commission, viz, a depth, when completed, of 6 feet at low water, with a width of 40 feet at bottom. To continue the excavation to these dimensions will require an appropriation of $26,000.

The nearest harbors of refuge are the Patuxent River, about 15 miles to the north, and Saint Mary's River, in the Potomac, about 30 miles distant. From its situation it is evident that Saint Jerome's would afford a convenient harbor of refuge, particularly for small sailing vessels and oyster-boats, if the bar at the mouth was removed.

The following appropriations have been made:

March 3, 1881	$6,500
August 2, 1882	5,000
July 5, 1884	15,000
Total	26,500

The work is in the collection district of Annapolis. The nearest light-house is Point Lookout, 6 miles distant.

STATISTICS OF TRADE.

No commercial statistics were received for the past year. Mr. G. G. Joynes furnished a statement of the trade during the year 1884, showing a total value of shipments and receipts of $167,800. (For items see Report for 1885, page 970.) There is a fishing station at this point.

A chart of Saint Jerome's Creek, showing work during the year and the buildings and hatching ponds of the United States Fish Commission, accompanies this report.

Money statement.

July 1, 1885, amount available		$6,210 63
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$3,739 10	
July 1, 1886, outstanding liabilities	40 00	
		3,779 10
July 1, 1886, amount available		2,431 53
Amount (estimated) required for completion of existing project		26,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		18,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

J 6.

IMPROVEMENT OF RAPPAHANNOCK RIVER, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A summary of operations from the commencement of the work to the close of the fiscal year ended June 30, 1882, will be found in the Report of the Chief of Engineers for that year page 1017; also in the Report for 1883, page 802. The report of the survey of Capt. Joseph F. K. Mansfield, made in 1852, will be found in the Report of the Chief of Engineers for 1874, page 36. In the same volume, Part II, page 32, will be found the report of the survey made in 1870.

(2) *Description of original condition.*—The Rappahannock from Fredericksburg, the head of navigation, to the Chesapeake Bay is about 106½ miles in length, measured on the charts. It enters Chesapeake Bay 119 miles below Baltimore. Its general course is southeast. Its width at Fredericksburg is about 300 feet, and it continues narrow, with two exceptions, namely, at Tobago Bay and Green Bay, as far as Occupacia Creek, 56½ miles below Fredericksburg, where its fluvial character disappears. At this point its width is about half a mile. From this point it gradually widens in its course and becomes, at its mouth, 3½ miles wide. The tides range from 2½ feet at the mouth to about 4 feet at Fredericksburg.

Freshets are of short duration, rising to about 20 feet at Fredericksburg, and are but slightly felt at Port Royal, 29½ miles below. (For table showing highest water at Fredericksburg for each month from 1879 to 1885, also for table of distances, see Report of 1885, pages 971 and 972.)

(3) *Plan of improvement.*—According to the original project, the proposed cuts were to have a navigable depth of from 9 to 10 feet at low water with a width of 100 feet at bottom through all the bars.

Training-dikes were recommended for the preservation of the depth, but the method of construction, position of the dikes, and estimate of cost were left for future determination.

In 1879 a general estimate was submitted which included these omissions and also the cost of increasing the depth and width of the channel. It was not practicable to fix precisely the location of the dikes or the dimensions of the cuts, as the work advanced slowly, and changes must occur before the point of improvement could be reached. The convenience of a general estimate is, however, obvious. The calculations were based on a channel which should have a width of from 100 to 150 feet and a depth of 10 feet at low water as far as Port Royal, 29½ miles below Fredericksburg, and thence to the mouth the channel should not be less than 200 feet in width with a depth of not less than 15 feet at low water. The estimate included such dikes as, at the time, seemed necessary. It was expressly stated that before beginning the improvement at any locality a careful survey and final plan should be prepared. The total cost of the work was estimated to be $291,000.

(4) *Amount expended and results obtained.*—From the adoption of the project in 1879 to the close of the fiscal year ended June 30, 1885, $65,445.31 were expended between Fredericksburg and Farley Vale bars (a distance of 12.6 miles) in dredging 119,061.8 cubic yards of sand and silt and in the construction and repair of dikes.

The results of this expenditure up to June 30, 1885, were as follows: Between Fredericksburg and Farley Vale the channel had a depth of not less than 8.1 feet at low water, and a width of about 100 feet for 12¼ miles, the distance improved.

The following table gives the results of the improvement at each of the bars, showing the depth before improvement, and the least depth in a width of 100 feet at the close of the fiscal year ended June 30, 1885:

Locality.	Depth at low water before improvement.	Least depth at low water, June 30, 1885.	Remarks.
	Feet.	*Feet.*	
Fredericksburg Bar	4.0	8.0	
Pollock's Bar	7.3	8.2	10 feet could be carried.
Bernard's Bar	8.5	9.4	
Pratt's Reach Bar	8.3	8.1	9 feet could be carried.
Spottswood (upper) Bar	6.0	8.5	
Spottswood (lower) Bar	6.0	8.3	8½ feet could be carried.
Castle's Ferry Bar	8.0	9.0	
Farley Vale Bar	8.0	10.4	10 feet could be carried.

The navigable depth at high water varied from 12 to 15 feet for a distance of 12.6 miles as far as the improvement had advanced.

WORK DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

(5) *Dredging.*—The contract for dredging under the appropriation of July 5, 1884, assigned to Daniel Constantine, the lowest bidder, at 19 cents per cubic yard, approved May 5, 1885, was continued into the present fiscal year. Work was begun June 11, 1885, and the contract was completed on November 30, 1885.

	Cubic yards.
The total net excavation under this contract was	38,243.6
Amount excavated to June 30, 1885	3,867.8
Total net excavation during fiscal year ending June 30, 1886	34,375.8

Fredericksburg Bar.—The deposits in the turning-basin at the steamboat wharf were removed to a depth which at the close of the work was about 10½ feet at low water, and the extreme width 240 feet. From the basin a channel was dredged for a distance of 3,920 feet, with a width of 80 feet and a depth at low water of 10½ feet. From this point (765 feet below Hazel Run) a channel of the same depth and 40 feet wide was continued for a distance of 920 feet, and stopped at the mouth of Deep Run.

The total amount removed from this bar during the year was 19,016 cubic yards.

Spottswood Bar (upper end).—The cut began in the channel about 400 feet above Dike No. 4, and was continued to a point 450 feet below Dike No. 18, a distance of 2,965 feet. For 600 feet the channel was made 80 feet wide, and for 2,365 feet it was made 60 feet wide.

The depth at low water was 10½ feet.

The amount of dredging on the bar was 15,359 cubic yards. The total removed from both bars during the year was 34,375 cubic yards. All the material removed was deposited behind the dikes.

At Spottswood Bar 5,119 cubic yards were re
of October 29, 30, and 31, 1885. This freshet de
It reached the height of 21 feet above low-wate
burg, and was the highest which has occurred in

In connection with the work at Spottswood Bar
seed must be mentioned. For a distance of 1,5
feet back from the water's edge locust seed was p
strain the spread of the water and to confine the c
to the course of the channel. The height of the ba
to the growth of locust than to that of willow.

(6) *Work done by day labor.*—At Fredericksburg
paired at a cost of $70, and strengthened at a cost

At Spottswood, upper end of bar, six mats were
the dike at a cost of 2.9 cents per square foot.

At Farley Vale six mats were sunk at the end of th
3 cents per square foot. The damage done to the
Bar by the freshet of October, 1885, has been repaire

SURVEYS MADE DURING THE FISCAL Y

Careful surveys of the bar at Nanzatico Reach an
were made in May and June, 1885. The report of the
zatico Reach is appended to these reports with two cha
and charts of the bar at Naylor's Hole are not submitt

The work required at this locality cannot be reached
priation for this year, and the report and charts are re
ther consideration;

(7) *Appropriations.*—The amount expended upon form
$90,500. The following appropriations have been made
project:

June 14, 1880
March 3, 1881
August 2, 1882
July 5, 1884

Total

These appropriations were made under the following gene
for improving the river from Fredericksburg to the 15-foot
Tappahannock, a distance of 64½ miles.

(8) Estimate of 1879
Amount appropriated up to June 30, 1886

Amount due on estimate
Amount appropriated by act approved August 5, 1886

Balance due on estimate

STATISTICS OF TRADE.

No statement of commercial statistics has been received. The Committe
merce furnished a statement for the year 1883 (see Report for 1884) showing

Total trade by water and rail	$4
Amount of business done by mills, factories, &c., was	2

The followings drawings accompany this report:

(1) Chart of Fredericksburg Bar.
(2) Chart of Spottswood Bar.
(3) Chart of Rappahannock River from Fredericksburg to the mouth.
(4) Chart of Rappahannock River from Fredericksburg to Farley Vale Bar.
(5) Chart of Nanzatico Reach—Hydrographic map.
(6) Chart of Nanzatico Reach, showing current observations.

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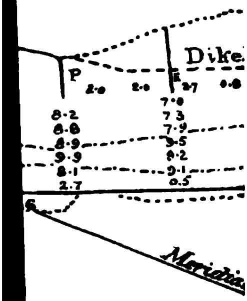

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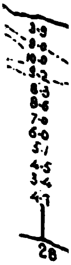

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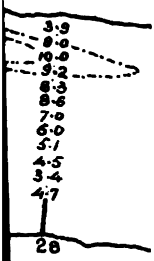

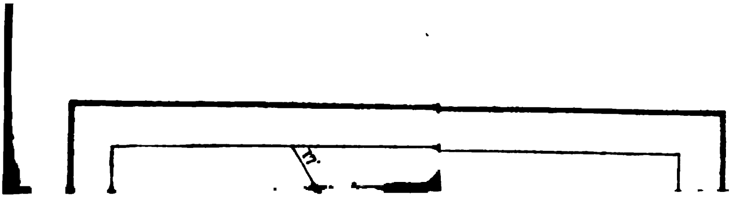
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Money statement.

July 1, 1885, amount available		$11,554 69
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$10,154 83	
July 1, 1886, outstanding liabilities	298 56	
		10,453 39
July 1, 1886, amount available		1,101 30
Amount appropriated by act approved August 5, 1886		20,000 00
Amount available for fiscal year ending June 30, 1887		21,101 30
Amount (estimated) required for completion of existing project		194,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		90,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

SURVEY OF BAR AT NANZATICO REACH AND TOBAGO BAY, RAPPAHANNOCK RIVER, VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., July 23, 1886.

GENERAL: I have the honor to submit the following report of the survey of the bar at Nanzatico Reach and Tobago Bay, in the Rappahannock River, Virginia, made between the 4th and the 23d of May, 1885:

Tobago Bay is 34 miles below Fredericksburg.

The object of the survey was to ascertain the nature of the obstruction to navigation, and to obtain the data necessary for the determination of the plan of improvement, and also for estimating the quantity of material to be removed and the cost of the work required.

Project.—The original project for improvement at this point contemplates securing a channel which shall, when completed, be 200 feet wide at bottom and 15 feet deep at low water.

Description of the bar.—The total length of the bar, from a point in the 15-foot curve below Nanzatico to the 15-foot curve below Long Point, is 5,540 feet. A narrow channel, not less than 10 feet in depth at low water, can be carried over the bar. In the course which can be conveniently followed by steamers the depth is 8.3 feet at low water, which is much less during the prevalence of unfavorable winds and tides. Below Long Point the channel is narrow—100 feet in width for distances which are together equal to 2,080 feet in length, and has the required depth of 15 feet at low water.

Two bays give an unusual width to the river at this locality.

Nanzatico Bay has a chord of 5,630 feet and is about the length of the bar. Its versed-sine is 2,815 feet or half its chord. Tobago Bay has a chord of 6,100 feet and a versed-sine about equal to the length of its chord.

These bays are undoubtedly a remnant of the prehistoric condition of the river, and to them the bar owes its existence. The least depth is found in the channel of Nanzatico Bay.

Triangulations.—A broken base line, 4,406.5 feet in length, was carefully measured along the shore above Long Point.

The area covered by the triangles is 1½ by 2½ miles, or 3¾ square miles.

The stations were marked and witnessed so that they could be identified.

Current observations.—These observations were confined mainly to the channel, and were made with the object of determining the direction and maximum velocity of the tides. The distance traversed by each float is shown upon the chart for every five minutes.

The maximum velocities observed are as follows:

	Miles per hour.
Flood tide, 1.5 feet per second	1.02
Ebb tide, 1.46 feet per second	0.99

The velocities observed were the mean of each vertical section, and are recorded on the chart.

Cross-sections and areas.—Soundings at distances of 10 feet along line C–I, and the areas calculated for mean, mid, and high tide are as follows:

Stage of tide.	Average depth.	Width.	Area.
		Feet.	*Square feet.*
Mean low tide	6.5	3,430	22,548
Mid-tide	7.5	3,460	25,983
High tide	8.5	3,490	29,466

The lines of mid-area and mid-volume have been drawn through points which have been determined as accurately as the number of observations would permit, and the lines of the maximum current of ebb and flood have been plotted on the chart, which is drawn to a scale of $\frac{1}{5000}$.

Sectional areas.—The sectional areas of the river, at right angles to the current, have been calculated from soundings taken on four lines. These lines were divided into sections corresponding to the different velocities observed, and the volumes passing each section at ebb and flood were carefully calculated. The aggregate of the volumes of each section gives the volume for the entire area upon each line.

All velocities were obtained at the time of maximum.

The point of mid-volume for each tide was calculated upon the same lines.

The lines of mid-volume and mid-area obtained in this way are believed to be sufficiently correct to determine the course of the proposed dikes.

The calculated cross-sections upon four lines are as follows:

Line on chart.	Remarks.	Width at mid-tide.	Area at mid-tide.
		Feet.	*Square feet.*
A–A′	Tidal current of ebb and flood above the bar in the same path	2,550	22,259
B–B′	Tidal currents across the bar in different paths	4,950	28,983
C–C′	Tidal currents just below the bar in different paths	3,664	27,510
D–D′	Below the bar and opposite Long Point the tidal currents are in the same path	7,420	41,315

Tides.—The tides were observed at Greenlaw's Wharf, 2 miles below the bar, for three months, between December, 1884, and March, 1885. The mean low water during the period of observation was found to be two-tenths (0.2) lower than the low water of the more regular summer tides.

A tide-gauge set at Long Point, whose zero was the mean of low water of summer and winter, was used as the reference for all soundings.

The zero of this gauge was referred to a mark on Long Point, formed by a nail driven into a bench cut upon an elm tree, which stands at high-water mark, about 350 feet above the Point. It is 3.44 feet above low water.

Another bench was established at Greenlaw's Wharf, 14 feet above the same plane of mean low water.

The range of tide deduced from 90 observations made between December, 1884, and March, 1885, is 1 9 feet. The range during the survey deduced from 20 observations is 2 feet. The highest tide observed was 2.7 feet; the lowest was zero.

All soundings were reduced to mean low water.

These soundings are 1 foot greater than those shown on the Coast Survey chart. This difference is probably due to the fact that the soundings upon the chart of the Coast Survey were referred to the zero at Fredericksburg. This conclusion is drawn from chart No. 523, dated December 29, 1853, which represents this part of the river from Tappahannock to Accaceek Point.

Simultaneous tide observations.—The height of the water surface was observed at three stations at the same instant, viz:

Station No. 1, at the head of Nanzatico Reach.

Station No. 2, just above Long Point, 1 mile below.

Station No. 3, 150 feet below Long Point.

Station No. 2 was taken as the datum.

The levels taken at high water at the same instant were as follows:

	Feet.
Station No. 1	0.037
Station No. 2	0.000
Station No. 3	—0.056

No observations were taken on the south side of the river.

Soundings.—All soundings were reduced to the low water of the gauge (No. 2) just above Long Point, and the soundings upon the lines of cross-section were taken every 10 feet along a chord.

The bottom was found to be for the most part of soft mud, offering no obstacle to dredging or pile-driving. At a point near Raccoon Island hard sand is found at a depth of 21 feet below low water, and at the bar opposite and below Long Point the substratum is composed of sand and gravel, which constitutes the surface.

Borings.—Seventeen borings were taken in the channel and along the probable sites of the dikes. The material composing the bar is soft mud, possessing greater consistence at the surface. It is penetrated without difficulty to 16 feet below low water. Opposite Long Point, a stratum of coarse gravel and hard sand makes penetration more difficult. Borings along the lines C–K and D–F, taken with a view to determine the probable penetration of piles passed through very soft mud, and penetrated with ease to depths varying from 18 to 23 feet, or from 20 to 30 feet below low water.

Below Raccoon Island the boring-rod penetrated sand which is much harder than that above the island. These borings, indicated upon the chart by circlets and Roman numerals, are given in a tabulated form below.

Table of borings taken at Nanzatico Reach, Rappahannock River, Virginia, May, 1885

No. of boring.	Position of boring.	Depth of water.	Penetration in bottom.	Penetration below low water.	Difficulty of penetration.	Kind of material.	Remarks.
		Feet.	*Feet.*	*Feet.*			
I	Channel, upper end of bar	12	6	18	None	Mud	Channel borings 50 feet from track of steamers.
II	Channel, middle of bar	10	6	16	do	do	
III	Channel, lower end of bar	10	6	16	do	do	
IV	Line C-K, 500 feet from C	3	20	23	do	do	On probable line of dikes.
V	Line C-K, 1,000 feet from C	......	19	......	do	Stiff mud	Do.
VI	Line C-K, 1,500 feet from C	5½	21½	27	do	do	Do.
VII	Line C-K, 2,000 feet from C	7	22	29	do	do	Do.
VIII	Line C-K, 2,500 feet from C	9	17	26	do	do	Do.
IX	Line C-K, 3,000 feet from C	9	20	29	do	do	Do.
X	Line C-K, 1,000 feet from K	2½	19½	22	do	do	Do.
XI	Line C-K, 500 feet from K	2½	19½	22	do	do	Do.
XII	Line D-E, at station D	4	19	23	do	do	Do.
XIII	Line D-E, 500 feet from D	5	18	23	do	do	Do.
XIV	Line D-E, 1,000 feet from D	3	23	26	do	21 feet mud, 2 feet sand below.	On probable line of dikes, at point of island.
VX	Line D-E, 1,500 feet from D	4	19	23	do	Mud and sand	On probable line of dikes.
XVI	Line D-E, 2,000 feet from D	4	19	23	do	do	Below island.
XVII	Channel line 50-53, 100 feet from 53	14½	3½	18	Very great	Coarse gravel	Off Long Point.

Freshets.—The freshets which reach an elevation of from 21 to 23 feet at Fredericksburg are reduced to one-third this height when they reach Nanzatico. The greatest elevation, according to Mr. Peyton Parker, which has been observed at Greenlaw's Wharf, 35½ miles below Fredericksburg, was 7.3 feet above zero, or about 5 feet above ordinary high water.

Dumping-ground.—There seems to be no convenient water space which can be used by deep-draught dumping-scows, and the number of fishing stations on the shore of Tobago Bay will make the selection of dumping-ground for shallow dumpers a matter of some difficulty. Side dumpers, drawing 5½ feet water when loaded, may be employed in the lower part of the bay at extreme high water, but the extent of ground which can be occupied is small. The dredged material may be judiciously used in building a low-water dike parallel with the channel and about 1,000 feet (or less) distant from it, and can be deposited between the 6th and 8th foot-curves. It may be necessary to protect this dike from erosion by means of mattresses or sheet-piles. Dumping cannot be permitted in the swash channel below Long Point, unless the subcurrent is insufficient to remove the material.

Results of the survey.—The object of the work so far accomplished has been to obtain, with as little cost as possible, a knowledge of the nature of the obstruction and sufficient data for a general estimate of the cost of an improvement necessary to give a channel with a width, when completed, of 200 feet at bottom and a depth not less than 15 feet at low water.

Causes which have concurred in forming the bar.—The bar is the effect of several causes, the chief of which is the sudden expansion of the river upon the left in Nanzatico Bay and upon the right in Tobago Bay, which expansions occur at a point where the river has lost much of its fluvial character at ordinary stages. To this primary cause are due the several co-operant effects, which may be named in the following order:

(1) The ebb and flood tides following the trend of the bays flow on different paths and with different velocities, the ebb tide taking the Nanzatico side, and the flood tide taking the Tobago side of the channel.

(2) At the turn of the tide and in the vicinity of the bar, the ebb current continues to run down on the north side of the channel for at least one hour after the flood tide begins to run up on the south side of the channel. Between these two currents slackwater intervenes.

3. The upward current continues for two hours in the channel after high water is indicated upon the gauge (No. 2) at Long Point; and the ebb current continues in the channel after the period of low water and during the rising of the water at the same gauge.

(4) The flood tide lasts 5½ hours; the ebb tide lasts 6¾ hours.

(5) The maximum velocity of the ebb is .99 miles per hour; the maximum velocity of flood is 1.02 miles per hour.

The flood has the greatest velocity; the ebb has the longest endurance. These forces are modified by the winds.

(6) The highest freshet observed at 1½ miles below Tobago was 5 feet above ordinary high water.

ESTIMATE.

The channel to be dredged is about 6,000 feet in length, 200 feet wide, and 15 feet deep at low water.

The amount of dredging will be 200,000 cubic yards; dike on the north side of the channel for 4,000 linear feet; dike on the south side of the channel for 2,600 linear feet. Total length of dikes, 6,600 linear feet.

The dikes should reach to half-tide. That on the north side should be first constructed. The dike on the south side can be completed as far as observation proves it to be necessary, for the preservation of the depth. The space behind the dikes will afford a suitable area for dumping the material dredged from the channel.

It is probable that the improvement will cost 33 per cent. more than the estimate submitted in 1879, on account of the reduction of the time of labor to eight hours per day instead of twelve hours, as was then the rule.

The survey was skillfully conducted by Mr. L. R. Grabill, assistant engineer, whose map is herewith submitted.

Very respectfully, your obedient servant,

S. T. ABERT,
United States Agent.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

J 7.

IMPROVEMENT OF TOTUSKY RIVER, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A report of a survey, made March 3, 1875, will be found in the Report of the Chief of Engineers for 1881, Part I, page 964.

(2) *Description of original condition.*—The Totusky is an affluent of the Rappahannock, into which it empties 35 miles above its mouth. It is

navigable for 5 miles to a point where it is crossed by the county bridge. A bar off the mouth, over which 4½ feet can be carried at low water, and a bar in the creek, over which 2½ feet can be carried, were the principal obstructions to navigation. The range of tide is 1½ feet.

(3) *Plan of improvement.*—The project of improvement consisted in building a dike 2,400 feet long at Booker's Bar, in the creek, and in excavating a channel parallel with it, having a width of 60 feet and a depth of 8 feet at low water. No work was proposed upon the bar off the mouth.

(4) *Amount expended and results obtained.*—Nine thousand five hundred and ninety-nine dollars and eighteen cents have been expended in constructing a dike 2,117 feet in length. The depth on Booker's Bar has increased half a foot from the effect of the current, but it will be necessary to dredge the channel as proposed in order to obtain the required depth at once. If Congress is disposed to complete the improvement, I would recommend the appropriation of $12,000.

The following appropriations have been made:

June 14, 1880	$2,500
March 3, 1881	2,500
August 2, 1882	5,000
Total	10,000

The work is in the collection district of Tappahannock, which is the nearest port of entry. The nearest light-house is Bowler's Rock, in the fifth light-house district.

STATISTICS OF TRADE.

No response was received to the requests sent out for a statement of commercial statistics. The total value of shipments and receipts for the year 1884, furnished by Mr. James F. Garland, and printed in the Report for 1885, page 977, was $63,200.

Money statement.

July 1, 1885, amount available	$400 82
July 1, 1886, amount available	400 82
Amount (estimated) required for completion of existing project	12,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	12,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

J 8.

IMPROVEMENT OF URBANA CREEK, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A history of operations to June 30, 1882, will be found in the Report of the Chief of Engineers for 1882, Part I, page 1029.

(2) *Description of original condition.*—This creek is a tidal tributary of the Rappahannock, and for vessels proceeding up-stream is the only harbor of refuge on the right or south bank of the river for a distance of 60 miles.

The obstructions consisted in a bar off the mouth, over which only 6 feet could be carried at low water, and a bar which contracted the channel in the harbor.

(3) *Plan of improvement.*—It was proposed to make a cut through the bar at the mouth, with a width of 150 feet and a depth of 10 feet. This plan was extended in 1883 (see Report of 1884) to include the removal of the bar in the harbor. The sand-spit at the mouth was re-enforced against the tides by a wattled dike.

(4) *Results obtained and money expended.*—Since the first appropriation, March 3, 1879, $15,500 have been expended. With this sum 58,729 cubic yards of material have been removed, at rates varying from 15 to 30 cents per yard.

At the close of the work the channel at the mouth was 120 feet wide and 10 feet deep, and the channel in the harbor had a width of from 80 to 400 feet, and a depth of about 10 feet.

(5) *Operations contemplated.*—With $6,000, which will complete the estimate, the channel at the mouth can be completed to a width of 150 feet, and the width of the harbor can be extended to 400 feet.

The following appropriations have been made:

March 3, 1879	$5,000
June 14, 1880	2,500
March 3, 1881	4,000
Aug. 2, 1882	4,000
Total	15,500

Urbana is a port of entry in the collection district of Tappahannock, and is a landing of the Rappahannock River boats of the Weems Line.

Money statement.

July 1, 1885, amount available	$68 59
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	40 00
July 1, 1886, amount available	28 59
Amount (estimated) required for completion of existing project	6,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	6,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

STATISTICS OF TRADE.

Mr. T. E. Sutton reports the total value of shipments and receipts $351,500. (For detailed statement see Report for 1885, page 978.)

J 9.

IMPROVEMENT OF MATTAPONI RIVER, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A report and estimate were submitted May 2, 1875. A full description of the part of the river which requires improvement, about 36 miles in length, and an account of the obstructions to navigation will be found in the Report of the Chief of Engineers for 1880, Part I, page 770.

(2) *Description of original condition.*—The Mattaponi River rises near Bowling Green, Va., flows southeast, and empties into York River at West Point, Va. It is navigable for 56 miles, and can be made navigable for barges for 25 miles above Aylett's, the head of navigation. From Murdy's Bridge to Aylett's snags obstructed the channel. From Aylett's to the head of Line Tree Bar, a distance of about 12¾ miles, the depth on the bar varies from 2½ to 3½ feet at low water. From the head of Line Tree Bar to the mouth the least depth is 6 feet at low water. The wrecks and snags between Aylett's and Latané's have not been removed. The tide is from 3 to 3½ feet above low water.

(3) *Plan of improvement.*—It was proposed to remove the snags and wrecks and to dredge a channel from the head of navigation to Line Tree Bar, which should have a bottom width of 40 feet and a depth of 5½ feet at low water. To preserve the depth in the channel it will be necessary to construct dikes.

(4) *Amended project.*—A re-examination of Robinson and Latané's bars was made in 1884. The amendments, which were not included in the first estimate, consist in the recommendation of a dike at each bar, to give permanency to the proposed channel.

The cost of improving Robinson's Bar was estimated at	$20,990	
The cost of improving Latané's Bar was estimated at	11,550	
		$32,540
Add 15 per cent. for contingencies		4,881
Total		37,421
Or in round numbers for the two bars		38,000
Balance due on original estimate		25,800
Total		63,800
Deduct appropriation of August 5, 1886		5,000
Amount due on estimates		58,800

From Latané's Bar to the mouth of the river the depth is not less than 5½ feet at low water. The channel is, therefore, sufficient for the present needs of navigation.

(5) *Future operations.*—The appropriation of $2,500 made July 5, 1884, was too small for economical work and was held until further appropriation should be made. The following appropriations have been made:

June 14, 1880	$2,500
March 3, 1881	3,300
July 5, 1884	2,500
Total	8,300

The work is in the collection district of Richmond, the nearest port of entry. The nearest light-house is Bell Rock.

Money statement.

July 1, 1885, amount available	$2,276 20
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	174 00
July 1, 1886, amount available	2,102 20
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	7,102 20
Amount (estimated) required for completion of existing project	58,800 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	58,800 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

STATISTICS OF TRADE.

No statement for 1885 has been received.

Total value of the natural products for 1884	$419,700
Total value of the manufactures for 1884	231,000
Total	650,700

The total amount of business in mills, factories, &c., for 1884, was 338,000. There were 542 vessels engaged in trade, with a total tonnage of 105,884 tons. (For details see Report of 1885.)

J 10.

IMPROVEMENT OF PAMUNKY RIVER, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A report of a personal examination of 30 miles of this river, with an estimate for removing the obstructions to navigation, was submitted May 21, 1875, and will be found in the Report of the Chief of Engineers for 1880, page 773. A history of operations until the close of the fiscal year ended June 30, 1882, will be found in the Report of the Chief of Engineers for that year. No work has been done since that date.

(2) *Description of original condition.*—Pamunky River rises in Osage County, flows southeast, and empties into the estuary of York River at West Point, Va. Its length from Hanovertown, the head of navigation, to the mouth is about 80 miles.

Between Hanovertown and New Castle Ferry, a distance of 9 miles, the least depth on the three bars varies from 1½ to 2½ feet at low water.

This part of the river can be made navigable for lighters or light-draught steamers.

Between New Castle Ferry and Piping Tree, a distance of about 19 miles, two bars only require improvement at the present time. The first of these is called Skidmore Bar, and is 13 miles below Hanovertown. The least depth is 5.8 feet at low water, and in a narrow channel. The second is 19¾ miles below Hanovertown, and is called Fox's Bar or Spring Bar. The least depth at low water is 5 feet.

(3) *Plan of improvement.*—The plan of improvement consisted in removing the logs, trees, snags, and wrecks which obstructed navigation between Hanovertown and Garlic's Mill, which is below Piping Tree, and in dredging through the bars from Hanovertown to Piping Tree.

From Hanovertown to Wormley's Landing the cut will be 3 feet deep; from Wormley's Landing to New Castle Ferry it will be 5 feet deep; below the Ferry the cuts will be from 6 to 7 feet deep at low water.

(4) *Amended project.*—A survey was made of Skidmore and Fox's bars in 1884. (See Report for 1885, pages 982 and 983.)

The cost of improving Skidmore Bar was estimated at	$3,846
The cost of improving Fox's Bar was estimated at	4,398
Total for the two bars	8,244
Balance due on original estimate	12,500
Total	20,744
Deduct appropriation of August 5, 1886	5,000
Amount due on estimate	15,744

(5) *Future operations.*—The appropriation of August 2, 1882, was too small for economical work, and was retained until further appropriation should be made.

The following appropriations have been made:

June 14, 1880	$2,500
March 3, 1881	2,500
August 2, 1882	2,500
Total	7,500

The work is in the collection district of Richmond, which is the nearest port of entry. The nearest light-house is Bell Rock.

STATISTICS OF TRADE.

No complete statistical statement was received for the year 1885, but Mr. Willeroy reports that the natural products were below the average on account of the drought in the fall of 1884. The total trade for 1883, reported by Mr. J. S. Neale, was $9,000,000.

Mr. Willeroy reports that the greatest need is the removal of wrecks of vessels sunk during the war, which makes navigation dangerous; and that trees have been blown down and become embedded in the stream, so that they have only 3 feet of water at high tide.

Money statement.

July 1, 1885, amount available	$1,876 39
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	120 00
July 1, 1886, amount available	1,756 39
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	6,756 39
Amount (estimated) required for completion of existing project	15,800 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	15,800 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

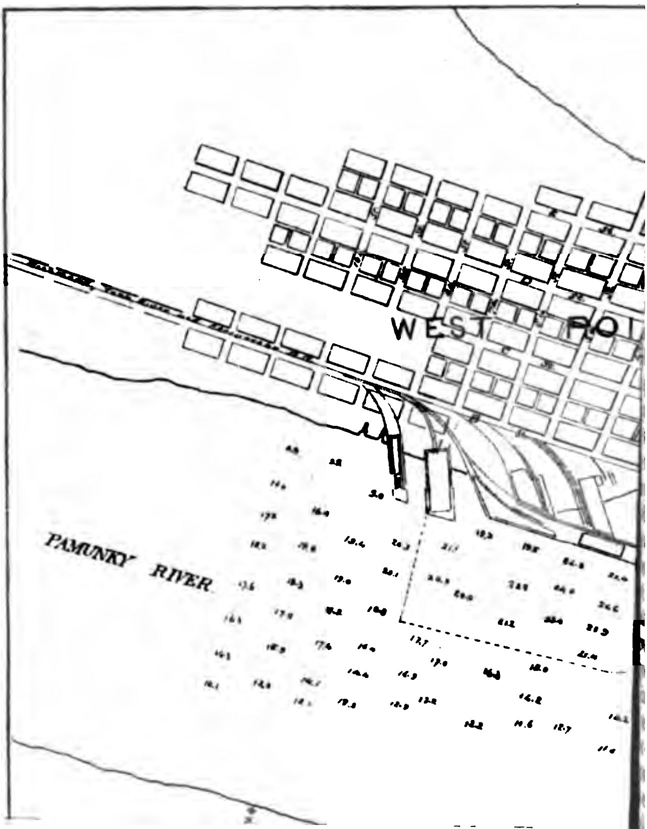
J 11.

IMPROVEMENT OF YORK RIVER, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A report of the survey of the bars at West Point, Va., and off Potopotank Creek, will be found in the Report of the Chief of Engineers for 1880, page 897. Work done since that date will be found in subsequent Annual Reports.

(2) *Description of original condition.*—The Pamunky and Mattaponi unite at West Point in forming the York River. The latter then follows a southeasterly direction for a distance of 41 miles, when it empties into Chesapeake Bay, about 16 miles in a line north of Fortress Monroe. Its course from West Point is noticeably straight for 31 miles. Its average width, as far as Yorktown, a distance of 26 miles, is 1½ miles. Before improvement, navigation was obstructed by two bars, one at West Point, about 2.1 miles in length, the other at Potopotank Creek, about 2,200 feet in length. The depth at West Point, at low


WEST PO
PAMUNKY RIVER

water, was 15½ feet; the depth at Potopotank Creek was 18½ feet at low water. With the exception of these two bars the depth in the channel was not less than 20 feet at low water.

(3) *Plan of improvement.*—Three estimates have been submitted; the one adopted is for dredging a channel 400 feet wide and 22 feet deep at low water.

The estimate amounted to $256,000.

(4) *Amount expended and results obtained.*—Up to June 30, 1885, $67,833.31 were expended in dredging 403,429 cubic yards of material.

At Potopotank Creek 58,809 cubic yards of material were dredged in 1880 and 1881, at the rate of 15 cents per cubic yard, which gave a channel 105 feet wide and 22 feet deep at low water. At West Point 344,620 cubic yards were dredged from October 4, 1881, to June 30, 1885, at rates varying from 8½ to 16 cents, which gave a channel with an average width of 150 feet and a least depth of 17½ feet.

(5) *Work done during the fiscal year ending June* 30, 1886.—This work was done by dredging under contract. The contract with Thomas P. Morgan, approved December 6, 1884, was completed on November 23, 1885. From June 30, 1885, to the completion of the contract 87,421 cubic yards were removed at 8½ cents per cubic yard. The total dredging under this contract was 163,338 cubic yards.

The dumping-ground extended from below Goff's Point to 1,200 feet below Golder's Creek. The depth of the water upon the ground before the material was deposited varied from 3 to 7.5 feet at low water. An examination was made in June, 1886, of the movements of the currents of ebb and flood, in order to determine the relation which they bear to the deposits observed near the confluence of the Mattaponi and Pamunky rivers and at the lower end of the new channel. The upper of these deposits is near Buoy No. 17, about 5,400 feet below the steamboat landing at West Point, and the lower deposit is at the turn of the channel near Buoy No. 13, about 10,100 feet below the same landing.

Further examination should be made of the effect of the Mattaponi and Pamunky rivers when loaded with sediment.

These examinations can be conducted during the progress of the work, and, when completed, will supply the data for determining the best method to be adopted to remove or diminish the deposit in the channel.

A solution of the question can be reached at an early day if the channel is promptly completed with the width and depth mentioned in the project.

The following appropriations have been made:

June 14, 1880	$10,000
March 3, 1881	25,000
August 2, 1882	25,000
July 5, 1884	20,000
Total	80,000
Original estimate	256,000
Amount appropriated	80,000
Due on estimate	176,000
Deduct amount appropriated by act approved August 5, 1886	18,750
Balance due on estimate	157,250

The work is in the collection district of Richmond, Va., which is the nearest port of entry. The nearest light-house is Bell Rock, in the fifth light-house district.

A chart of the bar at West Point, Va., accompanies this report.

Money statement.

July 1, 1885, amount available		$12,166 69
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$10,764 69	
July 1, 1886, outstanding liabilities	82 61	
		10,847 30
July 1, 1886, amount available		1,319 39
Amount appropriated by act approved August 5, 1886		18,750 00
Amount available for fiscal year ending June 30, 1887		20,069 39
Amount (estimated) required for completion of existing project		157,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		90,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

STATISTICS OF TRADE.

No statement of trade has been received for the year 1885. The totals of value are probably slightly greater than those stated in the Report for 1884, of which the following is a summary.

	Trade by water.	Trade by rail.
Natural products	$17,015,328	$17,715,718
Manufactures	10,269,700	1,457,500

	Capital.	Amount business in 1884.
Mills, factories, business houses, &c	$270,500	$3,057,500

Vessels engaged in trade during 1884.

	Number.	Total tons.	Greatest draught.
			Feet.
Steam	494	454,400	21½
Sail	214	85,600	22
Total	708	540,000	

The above summary of report of statistics, furnished by Mr. E. Wilkinson, includes the trade of the Piedmont Air Line Railroad, centering at West Point, its terminus; and also cord-wood, railroad-ties, and sumac shipped from the Mattaponi and Pamunky rivers.

J 12.

IMPROVEMENT OF CHICKAHOMINY RIVER, VIRGINIA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—The report of a personal examination, with an estimate for improvement, will be found in the Report of the Chief of Engineers for 1875, Part II, page 170.

An estimate for improving the bar at the mouth was submitted in 1882. (See Report for 1882, page 1041.)

(2) *Description of original condition.*—The Chickahominy River rises in Henrico County, Virginia, 12 miles northwest of Richmond; flows

southeast, and empties into the James River 40 miles from the mouth, and near Newport News. Its length from Forge Bridges to the James is about 44 miles. Between Forge Bridges and Windsor Shades the navigation is confined to lighters, and the chief obstruction at the time of survey consisted of snags and logs. At Windsor Shades, 19 miles below Forge Bridges, the depth was 4.5 feet. At Old-Fort Bar it was about 5 feet, and at Binn's Bar, 22 miles from Forge Bridges, the depth at low water was 4 feet. Thence no obstruction is encountered until the bar at the mouth is reached.

Over this bar 11 or 12 feet could be carried at low water in the year 1882.

The depth is influenced by the wind.

(For table of distances, see Report for 1885.)

(3) *Plan of improvement.*—It was proposed to improve the river for 19 miles between Forge Bridges and Windsor Shades by removing the logs, trees, and snags, and subsequently, if required by increase of trade, to dredge a channel through the bars. No estimate was submitted for this part of the improvement. It was also proposed to cut a channel through the bars at Windsor Shades, Old Fort, and Binn's, with a width of 100 feet and a depth of 8 feet at low water. The improvement was to be made at the mouth of the river by cutting a channel through the bar with a width of 200 feet and a depth of 15 feet.

(4) *Amount expended and results obtained.*—Ten thousand dollars have been expended at Windsor Shades, Old Fort, and Binn's bars, and $5,000 at the mouth; making a total of $15,000.

With this sum 45,197 cubic yards of material were removed from Windsor Shades, Old Fort, and Binn's bars, at an average rate of about 14.5 cents per yard, and 19,859 cubic yards were removed from the bar at the mouth at 22½ cents per cubic yard.

At Windsor Shades the cut was made with a width of 100 feet and a depth of from 8 to 9 feet at low water. At Old Fort Bar a cut was dredged to a width of 100 feet and a depth of from 8 to 9½ feet; but by filling at the side the width has since been reduced to 75 feet. At Binn's Bar the original width of cut was 200 feet, but subsequently was reduced by the caving of the sides of the cut to 160 feet. The depth is from 7½ to 8½ feet at low water. A cut was made through the bar at the mouth, with a width of 90 feet, a depth of 14 feet, and a length of 1,800 feet. No work has been done since 1883.

(5) *Future operations.*—The cut at the mouth should be made 200 feet wide, as originally projected, and the channel through the bar above should have the dimensions proposed.

The estimate for the bars in the river amounted to	$11,000
The estimate for the bar at the mouth amounted to	18,000
Total	29,000
Amount appropriated to June 30, 1886	15,000
Balance due on estimate	14,000
Amount appropriated by act approved August 5, 1886	4,000
Balance due on estimate	10,000

The following appropriations have been made:

June 13, 1878	$5,000
March 3, 1879	1,000
June 14, 1880	2,000
March 3, 1881	2,000
August 2, 1882	5,000
Amount appropriated to June 30, 1886	15,000

The work is in the collection district of Richmond, which is the nearest port of entry. The nearest light-house is Deep Water Shoal light-house, in the fifth light-house district.

Money statement.

Amount appropriated by act approved August 5, 1886	$4,000
Amount (estimated) required for completion of existing project	10,000
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

STATISTICS OF TRADE.

Mr. C. Perkins reports the number of steamers engaged in trade, 2; with greatest draught, 5 feet; sail vessels, 50; with greatest draught, 12½ feet. Total value of shipments and receipts, $460,000.

Mr. Perkins adds: "The principal trade is in wood, ties, and lumber. The vessels arriving here have difficulty in crossing the bar just below Binn's Wharf, and the bar just above Osborne's. I would advise the deepening of these points to 12 feet water."

NOTE.—The depths given above probably refer to high water.

J 13.

IMPROVEMENT OF STAUNTON RIVER, VIRGINIA, BETWEEN RANDOLPH STATION AND BROOK NEAL.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A report of an examination of the Staunton River, between Randolph Station (formerly Roanoke) and Brook Neal, will be found in the Report of the Chief of Engineers for 1879, part I, p. 622. A report of a survey and estimates will be found in the Report for 1880, p. 780. For history of operations since that date see subsequent Annual Reports.

(2). *Original condition.*—The principal source of the Staunton is not far from the Peaks of Otter, in Bedford County, Virginia. Its length is about 200 miles. It unites at Clarksville with the Dan River, and the stream thus formed is called the Roanoke.

The part of the river under consideration, between Randolph Station, on the Richmond and Danville Railroad, and Brook Neal, is about 31½ miles in length. (For further description see Report for 1885, pages 989 and 990.)

(3) *Plan of improvement.*—According to the original plan, it was proposed to employ spur-dikes and rock excavation to make a channel not less than 35 feet wide and 2 feet deep at low water. The estimate amounted to $68,700.

(4) *Amount expended and results obtained to June* 30, 1885.—The amount expended to June 30, 1885, was $25,069. This expenditure has resulted in making about 18 miles of the river navigable for small steamers.

(5) *Work during the fiscal year ending June* 30, 1886.—Active operations began July 7 and closed August 31, 1885, when the overseer was transferred to the Dan River improvement. A channel 35 feet wide at bottom and 2 feet deep at low water was cut through the following shoals: Britton's, Wesley's, Dennis's, Rice's, Michael's, and Bruce's. The excavation through Kirkpatrick Shoal (23½ miles above Randolph) was

pleted as far as Slide Rock, where work should be resumed next
on. A small amount of work was left undone at the foot of Bruce's
al.

even hundred and fifty-seven cubic yards of rock were removed from
channel.

rom the beginning of operations in 1880 a channel has been cut
ugh the bar between Randolph and Kirkpatrick Shoal (23½ miles),
a bottom width of 35 feet, and a depth of 2 feet at low water.

he mean level of the water surface during six or seven months is
2 to 3 feet above low water, which gives a depth during this pe-
of from 4 to 5 feet.

or the distance of 3 miles above Randolph the improvement is made
ing-dams, and for 20½ miles the improvement has been made by rock
vation.

rom the present condition of the channel it is believed that dams
not be needed at many of the localities, which, at the time of sur-
seemed to require their assistance in order to preserve the depth.
esurvey will be necessary before the question can be finally decided.

uring the year ending June 30, 1886, a steamer has been constructed
ly between Randolph and Brook Neal, and has made several suc-
ful trips. The plant is in fair condition, and is moored at Cole's
ry, under a competent watchman.

) *Remarks.*—The season for working in the river commences on June
d closes November 1. (For further remarks see Report for 1885,
e 990.)

profile of the Staunton River, from Brook Neal to Roanoke Station,
wing work completed up to end of fiscal year, June 30, 1886, accom-
ies this report.

he following appropriations have been made:

ch 3, 1879		$5,000
14, 1880		7,500
ch 3, 1881		5,000
ust 2, 1882		5,000
y 5, 1884		5,000
Appropriations to June 30, 1886		27,500
ginal estimate		68,700
propriations to June 30, 1886	$27,500	
act approved August 5, 1886	5,000	
		32,500
ount due on estimate		36,200

Money statement.

ly 1, 1885, amount available		$2,431 00
ly 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,695 38	
ly 1, 1886, outstanding liabilities	30 00	
		1,725 38
ly 1, 1886, amount available		705 62
ount appropriated by act approved August 5, 1886		5,000 00
mount available for fiscal year ending June 30, 1887		5,705 62
Amount (estimated) required for completion of existing project		36,200 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		20,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

STATISTICS OF TRADE.

Mr. Bruce writes, in response to a request for statistics of trade:

"While I am unable to give you accurate information which could be relied on as to the trade of the Staunton, I will state that a stern-wheel steamer 85 feet long, to run on the river, is now nearly completed, and no stronger evidence could be furnished of our faith in the future trade of our river or of the great benefit which the Government has conferred on us by improving its navigation.

"CHARLES BRUCE."

The following letter was subsequently received:

"I have made several successful trips with our steamer Jean up the Staunton River. I find that your plans and work have been a success to improve the river for a steamer. This gives great relief to a large section of Virginia, as along the Staunton River is one of the best sections of the State, and the people have been cut off from any outlet.

"You failed to stake off the channel you made, and until it is done we cannot make any time with the steamer, as the channels cross the river so often, with walls on both sides in some places. When the water is over them we cannot always keep in, and there is danger of running on the walls, as they are sharp rocks, and will soon cut in the boat.

"If you will send and have the channel staked off, I will furnish the steamer to your men, and help them all I can. It will not take more than ten days, as one side of the walls will do, as we could always see one side and know that the channel is 30 feet wide. My plan for staking it off would be to take a rod of iron 1 inch (in diameter) and 4 feet long, drill a hole 2 feet deep on the side of the wall, and leave the rod out 2 feet, with a 2-inch head on the end. The boat will run in 2 feet of water, and when the water is over the iron rods we could run over the walls; the rods being only 2 feet above the water; in high water nothing will hurt them, but, of course, this is just my idea.

"As I do not know what plan for staking off the channel will be best, and do not wish to dictate any, I will do all I can to help in any plan you may think best.

"I hope you will give this important matter your attention.

"I have no doubt that Congress will give you $10,000 for work on the river this year.

"Please send me a map of the river.

"Yours, very respectfully,

"A. J. TAYLOR."

J 14.

IMPROVEMENT OF STAUNTON RIVER, VIRGINIA, BETWEEN BROOK NEAL AND PIG RIVER.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A report of a reconnaissance and estimates of the part of the Staunton which lies between Brook Neal and Pig River will be found in the Report of the Chief of Engineers for 1882, page 1047. A more careful examination of the part of the Staunton between Pig River and the bridge of the Virginia Midland Railroad will be found in the Report for 1883, page 827.

(2) *Description of original condition.*—The distance from Pig River to Brook Neal is about 52 miles; the descent is 221 feet, and the average fall per mile 4.3 feet. Between these points the width varies from 150 to 350 feet. The valley through which it flows is from ½ to 1 mile wide.

The least depth on the shoals is about four-tenths of a foot at low water, but the river is navigated by batteaus in ordinary stages. The bottom of the river is, for the most part, of solid rock, and the gravel-bars, which are occasionally found, no doubt rest on rocky beds.

Freshets rise to the height of from 20 to 30 feet.

(3) *Plan of improvement.*—The object proposed by the improvement was to remove the obstacles to batteau navigation by employing spur-dikes, chiefly to reduce the slope of the water above, and by excavating rock

from the channel with the object of gaining depth as well as of reducing the slope.

The estimate for improving the river between Pig River and the railroad bridge, about 23½ miles, is $34,000.

The estimate for improving that part of the river between the railroad bridge and Brook Neal was based upon a reconnaissance made without instruments, and should be revised after a careful instrumental survey.

The width of the proposed channel above the railroad bridge is 14 feet, with a depth of 2 feet at low water.

(4) *Amount expended and results obtained.*—Two thousand dollars, appropriated August 2, 1882, were expended in making a cut through the rocks at Clement's Falls, just above the railroad bridge, and at Brown and Tuck's shoals, which are between 7 and 8 miles below Pig River.

The channel at Clement's Falls is now 20 feet wide and 1½ feet deep at low water. At Brown and Tuck's shoals the channel is now about 14 feet wide and 1½ feet deep at low water.

These operations extended over a distance of about 15 miles.

The total number of yards of rock removed is 535, at a cost of $2.80 per cubic yard.

Money statement.

July 1, 1885, amount available	$105 21
July 1, 1886, amount available	105 21
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,105 21
Amount (stimated) required for completion of existing project	27,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	27,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

J 15.

IMPROVEMENT OF DAN RIVER, VIRGINIA AND NORTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—The report of a survey from Danbury, N. C., to Danville, Va., will be found in the Report of the Chief of Engineers for 1879, Part I, page 652, and in the Report for 1880, Part I, page 788.

The Report of the survey from Danville to Clarksville will be found in the Report for 1880, page 794. A history of operations up to June 30, 1882, will be found in the Report for that year.

In the Report for each of the succeeding years will be found the history of operations since that date.

(2) *History of original condition.*—The Dan River rises near Buffalo Knob, in Patrick County, Virginia. From Danbury to Danville the distance is a little more than 78 miles; dividing this distance into two sections at Madison, the distance from Danbury to Madison is 28.39 miles, and the descent 10.24 feet per mile, a rate of descent not to be overcome for purposes of navigation, except by means of locks and dams. From Madison to Danville the distance is 49.81 miles, and the average descent 2.82 feet per mile, a rate of descent which makes improvement possible by means of spur-dikes and rock excavation. Im-

provement by this means is practicable, since the descent is not concentrated at a few localities.

(3) *Plan of improvement.*—The channel now being excavated for bateaux is 16 feet in width, and 2 feet in depth at low water.

(4) *Amount expended and results obtained up to June* 30, 1885.—Twenty-eight thousand one hundred and eleven dollars and ninety-nine cents were expended on the improvement of 5¼ miles (nearly) of channel above Danville.

(5) *Work done during the fiscal year ending June* 30, 1886.—One hundred and twenty-five cubic yards of rock were removed from the channel.

Dam No. 1, at Long Wall, was extended 160 feet, and Dam No. 6, at the lower end of Bull Sluice, was extended 103 feet.

The plant has been moored, and the property belonging to the French Broad River, North Carolina, has been stored at Wilson's Ferry under the charge of a watchman.

A resurvey was made of seven shoals at the following localities:

No.	Designation.	Miles above Danville.
I.	Slink's Shoal	47.50
II.	Three Island Shoal	44.75
III.	Eagle Falls	39.00
IV.	Galloway's Ford	35.25
V.	Tan Yard Shoal	20.50
VI.	Cow Ford Shoal	16.50
VII.	Ware's Shoal	15.00

From the beginning of the improvement up to June 30, 1886, a channel has been cut through all the bars between Danville and Wilson's Ferry (5½ miles) with a width of 16 feet and a depth of 1½ feet at low-water. To complete this part of the improvement according to the original design Dam No. 1 at the head of Long Wall should be extended 120 feet. Sufficient rock has been quarried for this object.

(6) *Future operations.*—When active operations are resumed work should commence at Glass and Butter Spring shoals, between 8 and 9 miles above Danville.

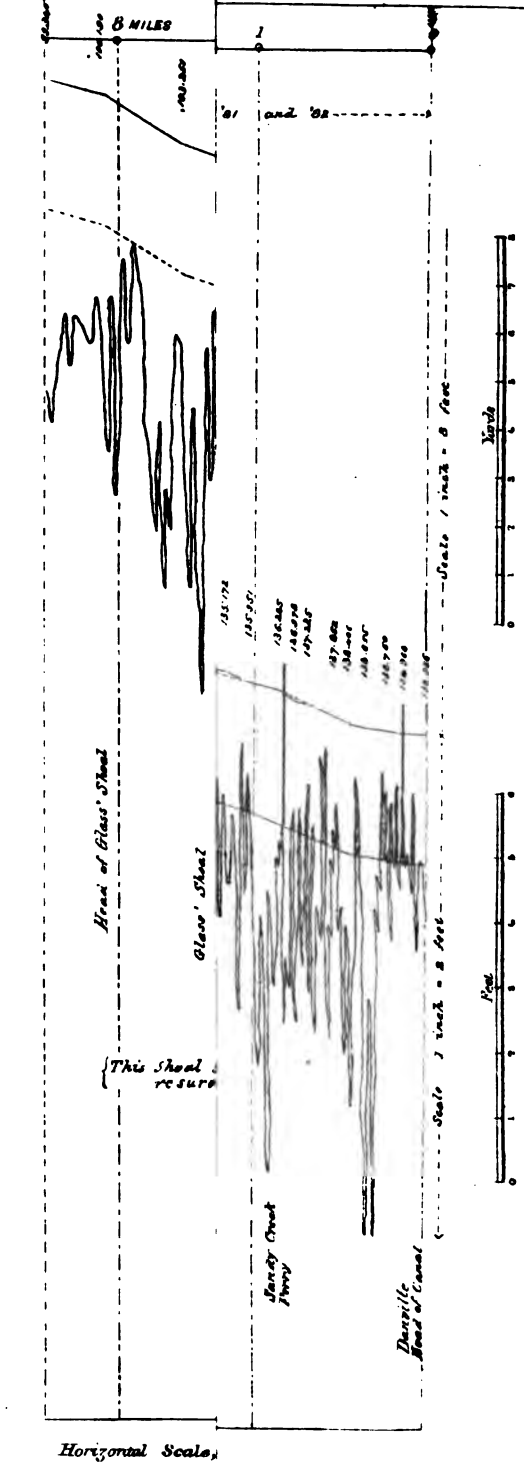
These shoals constitute the next serious obstruction encountered in ascending the river.

(7) *Remarks.*—The season for working in the river commences on June 1 and closes on November 1. (For further remarks, see Report for 1885, page 995.)

The following appropriations have been made:

June 14, 1880	$10,000
March 3, 1881	8,000
August 2, 1882	7,500
July 5, 1884	5,000
Amount appropriated to June 30, 1886	30,500

The estimate amounted to		52,000
Amount appropriated to June 30, 1886	$30,500	
Amount appropriated by act approved August 5, 1886:		
Improving Dan River, Virginia	10,000	
Improving Dan River, North Carolina	10,000	
		50,500
Amount due on estimate		1,500



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year ending June 30, 1886

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A profile of the Dan River, from Danville to the head of Long Shoal, showing work completed up to end of fiscal year ending June 30, 1886, accompanies this report.

Money statement.

July 1, 1885, amount available		$2,388 01
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,699 86	
July 1, 1886, outstanding liabilities	40 00	
		1,739 86
July 1, 1886, amount available		648 15
Amount appropriated by act approved August 5, 1886		20,000 00
Amount available for fiscal year ending June 30, 1887		20,648 15
Amount (estimated) required for completion of existing project		5,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		1,500 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

STATISTICS OF TRADE.

In response to a request for commercial statistics, Dr. Thomas L. Sydnor, of Danville, Va., writes as follows:

"The Dan River improvement has not yet extended far enough above Danville to develop the trade. Nearly all the receipts during the past year have been wood. When the improvement shall have extended 10 or 15 miles further, there will be opened a large section of country which has no convenient railroad depot, and will send to Danville immense supplies of wood and sawed lumber, receiving in return probably several hundred tons of guano. A large supply of guano was held in this place in the spring for this section, but obstructions in the river prevented the bateaux from going up. A small steam tug is now on the stocks, and will be launched as soon as the channel is opened a few miles further."

J 16.

IMPROVEMENT OF ROANOKE RIVER, NORTH CAROLINA, BELOW WELDON.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—An estimate for improving the river between Plymouth and Weldon will be found in the Report of the Chief of Engineers for the year 1872, page 726. In the Report of the Chief of Engineers for 1879, Part I, page 624, will be found a summary of operations previous to this time. Subsequent reports will be found for each year. The report of a survey made in 1883 will be found in the Annual Report of the Chief of Engineers for 1884, page 1022.

(2) *Description of original condition.*—The Roanoke is formed by the confluence of the Dan and Staunton rivers at Clarksville, Va.; thence to Weldon the distance is 68¾ miles.

From Weldon to the mouth of the Roanoke at Albemarle Sound the distance is 129½ miles. The general course of this part of the river is southeast. Steamboats occasionally reach Weldon at high water, but Caledonia, 25 miles below, is regarded as the head of light-draught (3½ feet at low water) steam navigation.

(For further remarks see Report for 1885, page 996.)

(3) *Plan of improvement.*—In the report of 1872 it was proposed: (1) To remove the wrecks, logs, trees, snags, and dangerous rocks; (2) to construct longitudinal dikes at all the sand-bars.

For maintaining a channel 5 feet deep at low water, the cost was estimated at $269,000. For maintaining a channel 8 feet deep at low water, the cost was estimated at $519,000. This expenditure was not recommended. In the report of 1884 the improvement of Big and Little Rocky bars was recommended after the removal of snags, which are brought down each year by the Dan and Staunton rivers.

The present project is limited to the removal of snags, and to a careful survey for the purpose of determining the best method of improving some of the bars, particularly Big and Little Rocky bars. The amount required for building the plant for removing snags and logs and for surveying Big and Little Rocky bars is $20,000. An expenditure for the removal of snags should be made when needed. The trade of the river is very important, and the small amount of money expended in removing snags will be a great benefit to navigation.

(4) *Amount expended and results obtained.*—Between March, 1871, and June, 1874, $45,000 were expended in removing rocks, snags, logs, and wrecks. After a suspension of nine years, an appropriation of $5,000 was made August 2, 1882, which was expended in completing the improvement of Indian Highland Bar. This work has proved to be satisfactory.

The appropriation of $3,000, made July 5, 1884, was retained until further appropriations should be made, the sum being regarded as too small for economical work.

(5) *Work done during the fiscal year ending June* 30, 1886.—No work has been done during the year.

Money statement.

July 1, 1885, amount available	$3,300 24
July 1, 1886, amount available	3,300 24
Amount appropriated by act approved August 5, 1886	20,000 00
Amount available for fiscal year ending June 30, 1887	23,300 24
Amount (estimated) required for completion of existing project	4,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	4,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

STATISTICS OF TRADE.

The following letter was received from Capt. A. M. Walker, of North Carolina, in reply to a request for statistics:

"In reply to yours of the 26th ultimo (February, 1886), I would respectfully suggest Capt. E. R. Latham as a suitable person to undertake the service. If you will address a letter, with forms, &c., to him in my care, I will attend to its prompt delivery and may be able to assist him to some extent in the work.

"I am thoroughly satisfied that after the bars and snags have once been removed, a suitable snag-boat, judiciously managed, say every alternate year, would be amply sufficient to keep the navigation in good condition. The steadily increasing trade to and from the Roanoke River should at least be a warranty to the Government for such an appropriation."

Capt. E. R. Latham, master steamer Meteor, R. N. and B. S. B. Co., furnished the following statement:

Articles.	Total value.	Articles.	Total value.
Natural products.		*Manufactures.*	
Bacon, beef and other cattle	$511,000	Agricultural machines and implements	$30,000
Coal	10,000	Corn meal	5,000
Cotton	2,500,000	Drugs and chemicals	25,000
Dairy products, eggs, and poultry	62,000	Fertilizers	300,000
Fish and oysters	35,000	Flour	300,000
Fruits and furs	6,000	Furniture	25,000
Grain	30,000	Groceries	300,000
Horses and mules	25,000	Hardware	25,000
Hay	75,000	Leather	5,000
Hides	25,000	Liquors	200,000
Iron (bar, pig; and scrap)	11,000	Mill machinery	25,000
Lard	40,000	Machinery (other than agricultural and mill)	25,000
Logs	25,000	Mill feed	5,000
Potatoes, peas, beans, peanuts, &c	45,000	Wagons, carriages, &c	50,000
Railroad ties	5,000	Woven fabrics	500,000
Staves and barrel timber	25,000		
Tobacco	25,000	Total	1,820,000
Wool	1,000		
Unclassified	10,000		
Total	3,466,000		

The number of vessels engaged in trade is 35, with a greatest draught of 7½ feet.

Business for the last year has been dull, on account of the small crop and low prices of cotton.*

If nothing else can be done toward the improvement of the Roanoke River, I would suggest the cutting off of the overhanging trees, which cause a vast deal of damage to the steamers plying up and down.

The taking up of the snags and logs would also greatly add to the improvement.

E. R. LATHAM.

PLYMOUTH, N. C., *April* 12, 1886.

J 17.

IMPROVING FRENCH BROAD RIVER, NORTH CAROLINA.

HISTORY OF OPERATIONS.

(1) *Reference to reports.*—A report and estimate for improving the part of the river between Brevard and Big Buck Shoals, in Buncombe and Henderson counties, North Carolina, will be found in the Report of the Chief of Engineers for 1878, page 525.

An estimate for improving the part of the river between Smith's Bridge and the foot of Long Shoal, made in accordance with the act of August 2, 1882, will be found in the Report of the Chief of Engineers for 1883, page 832.

A history of operations, showing the progress of the improvement since 1878, will be found in the Annual Reports of each year.

The reports of 1882 and 1883 give condensed statements of operations.

(2) *Description of original condition.*—Th Ferench Broad River rises near Cæsar's Head, a spur of the Balsam Mountain, in Transylvania County, North Carolina. The general course of the part of the river

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* The value of the cotton crop in 1883, as reported by Capt. A. M. Walker, was $6,250,000.

now under consideration, as far as Asheville, is northeast. (For fuller description see Report for 1885, page 997.)

The total distance from Wilson's Fish Trap to Smith's Bridge by the line of survey is 48.35 miles. The total descent from Wilson's Fish Trap is 130.94 feet.

(3) *Plan of improvement.*—The first appropriations were applied to the improvement of the river between Brevard and Big Buck shoals. After the removal of the logs and trees it was proposed to construct spur-dikes, and to excavate a channel through the ledges of rock which formed the bars. Under the act of August 2, 1882, appropriating $5,000, the same method of improvement was extended from Long Shoal to Smith's Bridge. The two projects were identical in their general features, and contemplated making channels 35 feet wide and 2½ feet deep at low water between Brevard and Big Buck shoals, and 30 feet wide and 2½ feet deep from Smith's Bridge to Long Shoal.

The cost of improvement from Wilson's Fish-trap to Big Buck shoals was estimated at	$46,000
The cost from Long Shoal to Smith's Bridge was estimated at	76,000
Total	122,000

(4) *Amount expended and results obtained to June* 30, 1886.

Aggregate of estimates		$122,000
Expended above Big Buck Shoals	$38,000	
Expended below Long Shoal	5,000	
		43,000
Due on estimates		79,000

Of this sum about $8,000 is due on the estimate for the part of the river above Big Buck shoals, and $71,000 for the part of the river between Long Shoal and Smith's Bridge.

About 26 miles of the river between Brevard and Big Buck shoals, and 4½ miles above Smith's Bridge have been improved, making a total of 30½ miles of improved channel.

The work will be continued above or below Big Buck Shoals as may be directed by Congress.

The appropriation should be divided as follows:

From Brevard to Big Buck shoals	$8,000
From the foot of Long Shoal to Smith's Bridge	32,000
Appropriation needed for the year ending June 30, 1888	40,000

Money statement.

July 1, 1885, amount available	$211 77
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	52 00
July 1, 1886, amount available	159 77

Amount (estimated) required for completion of existing project	79,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	40,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

J 18.

EXAMINATION OF THE AQUEDUCT BRIDGE ACROSS THE POTOMAC RIVER AT GEORGETOWN, DISTRICT OF COLUMBIA.

UNITED STATES ENGINEER OFFICE,
Washington, D. C., May 4, 1886.

GENERAL: I have the honor to submit my report of an examination of the Aqueduct Bridge over the Potomac River at Georgetown, D. C., made in obedience to the order of the Chief of Engineers, dated February 26, 1886, and in compliance with a resolution of the Senate, which is as follows:

> IN THE SENATE OF THE UNITED STATES,
> *February* 25, 1886.
>
> *Resolved*, That the Secretary of War be directed to cause to be made a careful examination of the Aqueduct Bridge at Georgetown, and report its present condition, especially as to its safety for ordinary travel when the aqueduct is filled with water.
>
> Attest:
>
> ANSON G. MCCOOK.
> *Secretary.*

A brief statement of the enactment relating to the legal status of the Aqueduct Bridge will be found in my report dated May 25, 1881 (House Ex. Doc. 156, Forty-seventh Congress, first session), in the remarks upon the fourth proviso of the act of March 17 of the same year.

That part of the legislative history of the Aqueduct Bridge which begins with the authority of the present lessees dates from the act of the general assembly of the State of Virginia passed on the 16th day of May, 1866. By this act, for the annual rent of $1,000, Henry H. Wells, Philip Quigley, and William W. Dungan became the lessees for the period of ninety-nine years. Under their authority and at their expense the bridge was completed March 19, 1868, and was declared a legal structure by act of Congress approved July 27, 1868. (See Statutes at Large, vol. 15, page 231.) This act consists of a preamble and seven sections, which are substantially as follows:

The preamble states that, by act of Congress of May 26, 1830, the Alexandria Canal Company was incorporated, and authorized to construct, operate, and maintain a canal from Georgetown, in the District of Columbia, to Alexandria, in the State of Virginia, with an aqueduct across the Potomac River at Georgetown; and, further, that, by an act of the General Assembly of the State of Virginia (February 16, 1866), the Board of Public Works was authorized to unite with the corporate authorities of the city of Alexandria in making disposition of the Alexandria Canal; and by joint vote of the Board of Public Works and by the vote of a majority of the stockholders of the said canal company the president and directors of the said canal company were empowered and directed to lease the said canal for the period of ninety-nine years; and that, on the 16th day of May, 1866, the said president and directors did grant, lease, and convey the said canal, its aqueduct, locks, banks, lands, gates, and property of all description to Henry H. Wells, Philip Quigley, and William W. Dungan.

Section 1 declares the aqueduct to be a legal structure.

Section 2 authorizes and empowers the lessees to maintain and operate said aqueduct, and also to erect, build, operate, and maintain upon and over the stone piers upon which the aqueduct now rests a bridge for the passage of persons, animals, and vehicles.

Section 3 empowers the lessees to lay out and operate a railroad across said bridge.

SEC. 4. *And be it further enacted*, That as soon as the Chief Engineer of the Army shall certify to the Secretary of War that the said bridge is so far completed as to be ready, fit, and convenient for the passage of persons, animals, and vehicles, the said lessees, and their legal representatives may demand, have, and receive, in advance, the following tolls, to wit: For any foot passenger crossing on said bridge, 2 cents; for any horse, mule, or jack, any ox, or other horned cattle, 5 cents; for any vehicle drawn by one animal, 15 cents; drawn by two animals, 25 cents; drawn by four animals, 35 cents, but no extra charge shall be made for the driver of such vehicle; for any hog, sheep, or other live creature, 1 cent; which cirtificate shall be published for three weeks in two daily papers in the city of Washington at the expense of the company: *Provided, however*, That it shall be lawful for said lessees to commute those rates to persons requiring yearly passes. * * * *Provided, however*, That said bridge is open and free for the passage of troops and munitions of war by the United States without charge or compensation or any kind.

SEC. 5. *And be it further enacted*, That in case the bridge shall not be fully completed within five years from the passage of this act, then this act shall be null and void.

Section 6 prohibits the lessees from granting exclusive privilege or rights to any corporation.

SEC. 7. *And be it further enacted*, That the right is hereby reserved to Congress to amend, alter, or repeal this act.

Approved July 27, 1868.

As before stated, the bridge was completed March 19, 1868; the certificate required by section 4 of the above act was issued January 9, 1869, in a letter by General A. A. Humphreys, Chief of Engineers, addressed to the Hon. J. M. Schofield, major-general and Secretary of War. By this certificate the bridge was declared "ready, fit, and convenient for the passage of persons, animals, and vehicles," and the lessees were authorized "to demand, have, and receive, in advance," the tolls as specified in section 4 above quoted.

GENERAL DESCRIPTION OF THE BRIDGE AS COMPLETED MARCH 19, 1868.

The piers of the aqueduct, constructed to carry the Chesapeake and Ohio Canal across the Potomac River, were built under the direction of Capt. William Turnbull, Corps of Topographical Engineers, and are composed of heavy blocks of gneiss, quarried about one mile below the Little Falls Bridge, on the Potomac; each pier has an ice-breaker of cut granite, quarried in Sandy Bay, Massachusetts. Between the abutments are eight piers, about 110 feet between the faces at the top; every third pier (two in all) is 16 feet wide at top; the remaining six piers are 7 feet wide. The top of each pier is about 30 feet above ordinary high-water mark. According to the first design the superstructure was to be of stone arches, but, for reasons of economy, a trough of kyanized wood was substituted, of the pattern designed by Colonel Long, of the Topographical Engineers.

The aqueduct was used by the Government during the war, the water being drawn from the trough, and a roadway laid upon the floor. This bridge becoming much decayed, its place was supplied by the lessees, who built the present structure, which is a Howe truss, strengthened by arch-ribs.

The trough of the aqueduct and the tow-path rest on the lower chord, and a highway bridge and foot-path rest on the upper chord.

Upon each of the narrow piers the arch-ribs of one span abut against the arch-ribs of the next span, a wrought-iron plate being inserted between them; over the abutment piers the arch-ribs abut against skew-backs of Georgia pine. At the north end three Howe trusses span the canal and connect the roadway of the bridge with one of the streets of Georgetown (Bridge street); at the south end a trestle bridge connects the roadway with the Virginia shore.

REPORT OF AN EXAMINATION CONCLUDED MARCH 16, 1886.

In making the examination a hatchet was used to sound the timber, and a pick and augur were employed to penetrate all such places as exhibited signs of decay. The condition of the parts will now be given in the same order as that adopted in the report of April 14, 1884.

For convenience of description I have divided the bridge into three general parts, beginning at the north end: First, the Georgetown approach; second, the aqueduct proper; and, third, the Virginia approach.

GEORGETOWN APPROACH.

This approach consists of three parts, viz:

	Feet.	In.
(1) An abutment and two stringers, 5 inches by 12 inches, with cross-planking from M or Bridge street to truss over canal	25	0
(2) Three trusses spanning the Chesapeake and Ohio Canal	107	9
(3) A series of trestles extending to the aqueduct proper, and supporting the roadway	173	0
Total	305	9

Its condition will now be given:

(1) The abutment is in fair condition.

(2) The trusses are strong and in good condition, but the floor beams, 6 by 12 inches in cross-section, resting on the lower chords, and supporting the carriage-ways and foot-paths, are in very bad condition.

The defective floor-beams are given below in order, beginning from he Georgetown end:

FLOOR-BEAMS OF EAST ROADWAY.

No. 3, rotten 6 inches in depth at end.
No. 4, rotten 3 inches in depth at end.
No. 5, rotten 4 inches in depth at end.
No. 6, rotten 5 inches in depth at end.
No. 7, rotten 6 inches in depth at end.
No. 8, rotten entirely through at end.
No. 9, rotten 6 inches in depth at end.
No. 10, rotten 6 inches in depth at end.
No. 11, rotten 4½ inches in depth at end.
No. 12, rotten 4 inches in depth at end.
No. 13, rotten entirely through at end.
No. 15, rotten entirely through at end.
No. 17, rotten entirely through at end.
No. 19, rotten entirely through at end.
No. 21, rotten 6½ inches in depth at end.
No. 22, rotten half cross-section at end.
No. 23, rotten 4 inches in depth at end.
No. 24, rotten 4 inches in depth at end.
No. 25, rotten entirely through at end.
No. 26, rotten two-thirds cross-section at end.
No. 27, rotten 5½ inches in depth at end.
No. 28, rotten entirely through at end.
No. 29, rotten 4 inches in depth at end.
No. 30, rotten 6 inches in depth at end.
One inner brace at Georgetown end of truss rotten 3 inches in depth.

FLOOR-BEAMS OF WEST ROADWAY.

No. 2, rotten entirely through at end.
No. 3, rotten 10 inches in depth at end.
No. 5, rotten 6 inches in depth at end.
No. 6, rotten 6½ inches in depth at end.
No. 8, rotten 2 inches in depth at end.
No. 9, rotten 8 inches in depth at end.
No. 11, rotten 2 inches in depth at end.
No. 14, rotten 4 inches in depth at end.
No. 17, rotten 5½ inches in depth at end.
No. 20, rotten 3½ inches in depth at end.
No. 21, rotten 10 inches in depth at end.
No. 23, rotten 1 inch in depth at end.
No. 27, rotten 10 inches in depth at end.
No. 29, rotten 3¾ inches in depth at end.
No. 30, rotten 5 inches in depth at end.
No. 33, rotten 4 inches in depth at end.

(3) The trestles are in good condition, but require slight repairs.

AQUEDUCT PROPER.

The elevation and plan in the drawing (A) present a view from the west looking down stream.

Reference is made by figures to panel points; the even numbers refer to the lower chord; the odd numbers refer to the top chord.

This division contains the roadway and aqueduct beneath it, and each span is constructed of wood, of the pattern known as the Howe truss. It is composed of two trusses, an up-stream truss and a down-stream truss. Each truss is between two arch-ribs, making four arch-ribs in each span. Each arch-rib is composed of four pieces, except the up-stream rib, which has five pieces.

There are nine spans. The average length of each chord is 116.84 feet; the total length between extreme angle blocks is 1,064 feet.

The following statement includes the counter-braces, which were omitted in the report of 1884. The dangerous effect of the moving load upon these braces is neutralized when the bridge carries its load of water. All timbers were examined which exhibited to the ear, when they were sounded, or to the eye some indication of deterioration. Many defective timbers may have escaped examination.

The condition of the various parts as ascertained by the examination is as follows:

FIRST SPAN.

Down-stream truss and arch.

At 2, end of first and third pieces of inner and third piece of outer arch-rib rotten.

At 2, 4, and 6, fourth piece of arch-rib rotten.

At 4, angle-block broken.

At 6, outer brace rotten 2 inches in depth; counter worthless, old, and cut away at end.

At 12, counter loose.

At 13, first, second, and third pieces of arch-rib rotten 3 inches in depth; angle-block crushed.

At 14, third piece of cord rotten.

At 17, fourth piece of inner arch-rib rotten 5 inches in depth; angle-block broken.

At 18, carriage-beam rotten.

From 18 to 20, fourth piece of inner and outer arch-ribs badly rotten.

Up-stream truss and arch.

At 2, first, second, and third pieces of arch-rib rotten; three posts rotten.

At 4, carriage-beam weather-cracked and rotten; fourth piece of arch-rib rotten.

From 5 to 11, first and second pieces of chord rotten 2 and 3 inches in depth.
At 6, first and second pieces of chord slightly rotten.
From 6 to 8, first piece of arch-rib rotten.
At 8, 10, and 12, carriage-beams rotten, split, or defective.
At 10, counter too short; does not reach angle-block.
At 12, counter lacks 6 feet of reaching chord.
At 13, fourth piece of chord rotten 3 inches in depth.
At 14, all pieces of chord slightly rotten.
At 15 and 17, angle-blocks broken.
At 20, second piece of arch-rib crushed; fourth piece rotten.

SECOND SPAN.

Down-stream truss and arch.

From 3 to 5, third piece of arch-rib rotten.
At 4, carriage-beam split and rotten; angle-block broken.
From 4 to 6, first, second, and third pieces of arch-rib rotten and shaky.
At 5, fourth piece of arch-rib rotten.
At 7, second and third pieces of arch-rib rotten 4 inches in depth.
From 7 to 9, fourth piece of arch-rib rotten.
At 8, counter worthless; old timber.
At 10, counter rotten.
From 10 to 12, second and third pieces of chord rotten.
At 12, fourth piece of chord rotten; both counters rotten.
At 13, suspension block crushed.
From 13 to 19, fourth piece of arch-rib rotten and shaky.
At 14, second and fifth pieces of chord rotten; timber and counter defective.
At 15 and 18, angle-blocks broken.
At 16, first piece of outer arch-rib crushed; second and third pieces of chords rotten.
At 18, third piece of chord and third and fourth pieces of inner arch-rib rotten 2 inches in depth.

Up-stream truss and arch.

At 1, first piece of chord rotten half way through.
At 2, outer post rotten; side of arch-rib rotten.
From 2 to 4, top piece of arch-rib rotten 3 inches in depth; old and split.
At 3, second piece of chord rotten 4 inches in depth.
At 5, 6, 15, and 17, angle-blocks broken.
At 5, first piece of chord rotten 4 inches in depth.
From 7 to 11, second piece of chord rotten 3 inches in depth.
From 9 to 13, top piece of arch-rib cracked, rotten, and cut into.
At 10, outer brace rotten 3 inches in depth and weather-cracked; counter rotten at foot.
At 10, 12, and 18, carriage-beams old and rotten.
At 13, first and third pieces of chord rotten 3 and 4 inches in depth.
At 14, outer brace rotten 2 inches in depth.
At 15, top piece of arch-rib rotten 4 inches in depth.
At 16, outer brace half section rotten.
At 17, first piece of chord rotten 3 inches in depth.
At 18, angle-block crushed.

THIRD SPAN.

Down-stream truss and arch.

At 2, outer post rotten at foot.
From 2 to 8, first piece of chord old, rotten, and weather-cracked.
At 3, 4, 5, 6, and 7, angle-blocks broken.
From 7 to 11, top piece of arch-rib badly rotten and weather-cracked.
At 10, under side of chord crushed into and rotten.
At 12, third piece of chord rotten; chord somewhat crushed between angle-block and gib-plate.
At 13, inside of outer arch-rib rotten where braces cross.
From 13 to 15, first piece of chord weather-cracked and rotten.
At 15, outer brace old and rotten.
From 14 to 16, second piece of chord rotten.
At 16, counter broken.
At 20, top piece of inner arch-rib rotten.

Up-stream truss and arch.

From 2 to 4, first piece of arch-rib rotten; fifth piece rotten entirely through.

At 3, 5, 6, 7, 16, and 18, angle-blocks broken.

At 4, second piece of chord rotten 3 inches in depth.

At 6 and 18, carriage-beams rotten and weather-cracked.

At 7, second piece of chord rotten 4 inches in depth.

At 8, outer brace rotten 5¼ inches in depth.

At 9, first piece of chord rotten 6 inches in depth.

From 9 to 11, first and third pieces of chord rotten 3 inches in depth.

From 9 to 13, top piece of arch-rib rotten entirely through.

At 12, both counters very poor; cracked and sections small.

From 13 to 15, first and third pieces of chord rotten from 3 to 4 inches in depth.

At 15, top piece of outer arch-rib rotten 5 inches in depth.

At 18, third piece of chord rotten 2 inches in depth; inner brace rotten 4 inches in depth.

At 20, first piece of chord rotten 3 inches in depth; three braces rotten 3 inches in depth; inner post rotten 6 inches in depth.

FOURTH SPAN.

Down-stream truss and arch.

At 1, both posts shaky.

At 2, timber skew-back crushed; third piece of arch-rib rotten.

At 3, 5, 7, 10, 12, and 15, angle-blocks broken; at 10, badly crushed.

At 4, inner side of arch-rib rotten; carriage-beam weather-cracked and rotten; timber of both braces old, weather-cracked, and defective.

At 5, fourth piece of chord shaky.

At 6, third and fourth pieces of chord rotten.

From 7 to 15, top piece of arch-rib old, weather-cracked, and rotten.

At 18, under side of carriage-beam rotten and crushed.

Up-stream truss and arch.

At 2, fifth piece of outer arch-rib and whole of inner arch-rib rotten; about half section of inner brace rotten; inner post partly rotten.

From 2 to 4, second piece of chord rotten 6 inches in depth; fourth piece half section rotten.

At 5, top piece of arch-rib rotten 5 inches in depth.

At 6, chord lacks 4 inches of cross-section.

At 7, 8, and 14, angle-blocks broken.

At 8, second piece of chord rotten 6 inches in depth; third piece of chord rotten 3 inches in depth.

From 9 to 11, first and third pieces of chord rotten 2 and 3 inches in depth.

From 9 to 13, top piece of outer arch-rib very defective.

At 10, counter 4 feet short of reaching chord.

At 10 and 14, carriage-beams rotten and weather-cracked.

At 12, third piece of chord rotten 5 inches in depth; fourth piece rotten 3 inches in depth.

From 13 to 15, top pieces of outer and inner arch-ribs rotten and cracked.

At 14, outer brace rotten entirely through.

At 16, both braces rotten 5 inches in depth.

From 18 to 20, fourth piece of chord and inner post rotten; fourth piece of inner arch-rib rotten half-way through.

At 20, in outer arch-rib at end, first piece rotten half-way through; second and third pieces wholly rotten; fourth piece four-fifths of section rotten; fifth piece slightly rotten.

FIFTH SPAN.

Down-stream truss and arch.

At 3, 4, 5, 7, 13, and 15, angle-blocks broken.

At 6, outside brace slightly rotten; counter lacking.

From 6 to 10, fourth piece of chord rotten.

From 7 to 15, top piece of arch-rib old and rotten.

At 8, outer brace rotten 3½ inches in depth.

At 10, blocking on carriage-beam rotten.

At 11, second piece of chord rotten 5½ inches in depth; inner brace shaky and rotten.

At 12, second and fourth pieces of chord rotten 3½ inches in depth.

From 13 to 15, top piece of inner arch-rib rotten and shaky.

At 14, carriage-beam rotten; second and third pieces of chord rotten 2½ inches in depth.

Up-stream truss and arch.

At 2, outer post out of place; second, third, and fourth pieces of arch-rib rotten 4 to 6 inches in depth.

From 2 to 4, first and second pieces of chord rotten 3 to 3½ inches in depth.

At 3, 4, 5, 6, 15, and 18, angle-blocks broken.

At 6, 8, 10, and 18, carriage-beams old, weather-cracked, and rotten.

At 8, counter rotten at foot.

At 10, gib-plate crushed into chord.

At 12, one counter 5 feet short; other counter old and rotten at foot.

At 12 to 14, second piece of chord rotten 2 inches in depth.

At 13, second piece of chord rotten 3½ inches in depth.

At 14, third, fourth, and fifth pieces of chord rotten 2 to 4 inches in depth, and weather-cracked.

SIXTH SPAN.

Down-stream truss and arch.

At 1, third piece of arch-rib old and rotten.

At 3, 5, 7, 13, 15, 17, and 18, angle-blocks broken.

At 4, outer brace rotten 2 inches in depth.

From 6 to 8, second, third, and fourth pieces of chord rotten 2 to 3½ inches in depth.

From 7 to 15, top piece of arch-rib old and rotten.

At 12, second piece of chord rotten 2 inches in depth; counter worthless, rotten at end, section small.

At 13, outer brace crushed and split at upper end.

From 14 to 16, second and third pieces of chord rotten 2 to 2½ inches in depth.

At 16, gib-plate crushed into chord.

At 20, inner post rotten.

Up-stream truss and arch.

At 2, third and fourth pieces of arch-rib rotten 3 inches in depth.

At 4, 6, 15, and 16, angle-blocks broken.

At 4, 8, 12, 14, and 16, carriage-beams old, weather-split, and rotten.

From 5 to 9, top piece of outer arch-rib rotten.

At 6, defective blocking at carriage-beam.

At 8, counter 5 feet short of reaching chord.

From 9 to 11, second and third pieces of chord rotten 3 inches in depth.

At 10, one-third section of outer brace rotten.

At 12, timber of both counters poor and old.

At 15, third piece of chord rotten 3 inches in depth.

At 17, top piece of arch-rib rotten and weather-cracked.

At 18, first piece of inner arch-rib crushed and worthless.

At 20, top piece of outer arch-rib cracked; timber skew-back slightly crushed.

SEVENTH SPAN.

Down-stream truss and arch.

At 2, half section of inner post rotten; second and third pieces of outer arch-rib rotten 1½ to 3 inches in depth.

At 3, angle-block broken in two places, and crushed into chord.

At 4, 5, 15, 17, and 18, angle-blocks broken.

At 4, end of inner brace crushed; second piece of chord rotten 6 inches in depth.

From 7 to 13, top piece of outer arch-rib old, rotten, and cut into.

At 8, timber of outer brace old, crushed at foot, and rotten.

At 10, 12, 14, and 18, timber of carriage-beams old, weather-cracked, or rotten.

At 10, both braces shaky, rotten, and crushed at foot; wooden blocking cracked; third piece of chord old and rotten.

At 12, third piece of chord rotten 2½ inches in depth; both counters, old timber and small section.

At 14, outer brace rotten 6 inches in depth; inner brace slightly rotten; counter loose.

At 15 top piece of inner arch-rib rotten 2 inches in depth.

Up-stream truss and arch.

From 1 to 3, first piece of chord rotten 3 inches in depth.
At 2, fourth piece of outer arch-rib rotten 4 inches in depth.
At 3, 5, 15, and 17, counters short; do not reach chord.
At 4, 5, 6, and 15, angle-blocks broken.
At 4, 6, 10, 12, and 14, carriage-beams old, weather-cracked, or rotten.
From 9 to 13, top piece of outer arch-rib rotten entirely through.
At 12, one counter 5 feet short; the other counter poor and of only half section.
At 15, second and third pieces of chord rotten 1 to 3 inches in depth.
At 20, second, third, and fourth pieces of outer arch-rib rotten, nearly worthless.

EIGHTH SPAN.

Down-stream truss and arch.

At 2, end of third piece of inner arch-rib rotten.
At 3, 4, 5, and 6, angle-blocks broken.
At 6 and 18, carriage-beams crushed and shaky.
At 6, two pieces of chord rotten 4 inches in depth.
From 7 to 11, top piece of arch-rib old, weather-cracked, and cut into.
At 8, first, second, and third pieces of chord rotten from 1 to 6 inches in depth.
From 9 to 12, inner brace rotten at ends.
At 12, one counter 4 feet short, the other very poor.
From 12 to 14, first and third pieces of chord rotten 3 and 4 inches in depth.
At 14, third and fourth pieces of chord rotten 2 and 6 inches in depth; fifth piece poor.
At 15 and 17, counters too short; do not reach chord.
At 20, half section of both posts rotten.

Up-stream truss and arch.

At 2, first piece of outer arch-rib worthless at end; second poor; third and fourth rotten 5 inches in depth; fifth slightly rotten.
At 3, 7, 13, 15, and 17, counters too short; do not reach chord.
At 4, angle-block broken in two places.
At 4 and 12, carriage-beams old and weather-split or rotten.
From 7 to 9, lateral brace rotten.
At 9, first piece of chord rotten 2 inches in depth.
From 9 to 15, top piece of outer arch-rib weather-cracked and rotten.
At 10, third piece of chord rotten 5 inches in depth.
From 11 to 13, intersection of lateral braces rotten.
From 12 to 16, top piece of outer arch-rib cracked at end.
At 14, third and fourth pieces of chord rotten 4 to 6 inches in depth.
At 14 and 18, angle-blocks broken.
From 17 to 19, third piece of chord rotten 3 inches in depth.
At 18, top piece of outer arch-rib old and rotten.
At 20, second piece of outer arch-rib at end rotten 4 inches in depth; third and fourth rotten 2 inches in depth; fifth worthless.

NINTH SPAN.

Down-stream truss and arch.

At 2, first piece of outer arch-rib at end rotten about half section; second piece slightly rotten.
From 2 to 4, first piece of chord rotten 5 inches in depth.
At 4, 6, 13, and 18, angle-blocks broken.
From 5 to 9, fourth piece of chord old and rotten.
At 6, inner brace old, rotten, and crushed.
At 7, block of suspension-rod rotten; counter too short.
From 7 to 19, top piece of outer arch-rib weather-cracked and rotten.
At 8, quarter section of inner brace rotten.
At 8 and 16, carriage-beams old and shaky.
From 8 to 9, inner brace old and weather-cracked.
At 10, angle-block crushed.
At 12, counter-brace lacking.

At 18, second, third, and fourth pieces of inner arch-rib rotten at side 2 inches in depth.

At 20, second piece of arch-rib rotten entirely through; third piece slightly rotten.

Up-stream truss and arch.

At 2, first piece of outer arch-rib rotten half section; second piece one-third section; third piece slightly rotten; fifth piece rotten entirely through.
At 4 and 18, angle-blocks broken.
From 5 to 7, first piece of chord rotten 2 inches in depth.
At 6, counter old and too short.
At 8, carriage-beam old and rotten.
At 10, one counter 4 feet short; the other counter 5 feet short.
At 11, first piece of chord rotten 4 inches in depth.
From 11 to 15, second piece of chord rotten 6 inches in depth.
From 10 to 12, third piece of chord rotten 3 to 4½ inches in depth.
From 12 to 18, top piece of inner arch-rib old and split.
At 14 and 16, counters 4 and 5 feet short.
From 18 to 20, second piece of inner arch-rib rotten entirely through.
At 20, second piece of arch-rib at end rotten 4 inches in depth; third and fourth pieces rotten entirely through; inner post weather-cracked.

The following further remarks are made in continuation of the examination of the aqueduct proper:

Counter-braces.—The counter-braces in many panels are lacking, and in others defective. Their use is mainly to resist moving loads, and any defect in them does not render the bridge unsafe when the aqueduct contains water.

Floor-beams of the aqueduct.—The plan calls for forty-five floor-beams beneath the trough. New beams have been placed beneath the floor; but in many of the spans old and decayed beams still remain. The number of good beams varies from thirty-five in the second span to fifty-five in the fourth and seventh spans.

Floor-beams of the deck or roadway.—The deck-beams and the stringers which rest on them require a general overhauling. Many of them are decayed. It was difficult to reach these beams, but from observations from below I should recommend the removal of the following, viz: Nine in the first span, eleven in the second, thirteen in the third, eight in the fourth, six in the fifth, eight in the sixth, nine in the seventh, thirteen in the eighth, and nine in the ninth; a total of eighty-six.

Hand-railing.—The hand-railing on both sides of the bridge is defective, and should be replaced.

Lateral braces to resist wind-strain.—Since the examination of 1884, the braces which were wanting in the upper chord have been replaced; but the braces of the lower chord remain in the same condition as when last examined, and cannot be replaced without removing the substruts beneath the bridge. The lateral braces which have been removed are shown by dotted lines. Their places are now supplied by the timbers A, B, and C. The straining-beam B is placed on the inside of the down-stream chord, which is the concave side; it extends for the distance of five central panels, and transfers the strains through the struts A and C to the foot of the first and last panels on the opposite or up-stream side of each span. This change was made necessary by the introduction of substruts and straining beams beneath the floor of the aqueduct, which has been employed to convey the pressure of the water to the piers. Each truss has also been connected with the piers by substruts.

Notwithstanding the support of the substruts, the bridge exhibits a tendency to turn about its horizontal axis, which tendency, first noted in 1876, was examined in 1884 and now again in March, 1886.

The following tables show the measurements of the overhanging of the chord and arch of each span which were made in the years 1884 and 1886:

Horizontal distance that the top chord overhangs the lower chord at the several piers, the inclination being up-stream.

Place.	Examination of 1884.	Examination of 1886.	Place.	Examination of 1884.	Examination of 1886.
	Inches.	*Inches.*		*Inches.*	*Inches.*
Georgetown abutment	4⅛	0	Fifth pier	—3⅛	—0⅝
First pier	8½	4½	Sixth pier	12	6⅛
Second pier	10¼	7	Seventh pier	9½	6
Third pier	16	5⅜	Eighth pier	11	6⅜
Fourth pier	3¾	2⅛	Virginia abutment	7	3¼

Horizontal distance that the top of the arch overhangs a verticle plane through the feet of the arch, the inclination being up-stream.

Place.	Examination of 1884.	Examination of 1886.	Place.	Examination of 1884.	Examination of 1886.
	Inches.	*Inches.*		*Inches.*	*Inches.*
Center of first span	5⅛	1⅝	Center of sixth span	6	2¼
Center of second plan	9½	4½	Center of seventh span	13	9¼
Center of third span	14	6⅞	Center of eighth span	11	7¼
Center of fourth span	6½	2⅞	Center of ninth span	8⅜	4⅝
Center of fifth span	—3	—2⅞			

This twisting or overhanging is due to the fact that the center of gravity of the bridge, when loaded with water, is 1.3 feet to the west of the center of gravity of the bridge without the aqueduct and water.

The removal of the lateral braces may in some measure encourage this tendency, which is the probable cause of the deviation of the lower chord from a straight line. The convex side is up-stream. The amount of deviation is shown in the following table:

Ver. sin. of chord.

Number of span.	Examination of 1884.	Examination of 1886.	Number of span.	Examination of 1884.	Examination of 1886.
	Inches.	*Inches.*		*Inches.*	*Inches.*
First	5	1½	Sixth	7	1
Second	6	3	Seventh	10	5⅜
Third	11	5⅛	Eighth	8½	6⅛
Fourth	3¾	1	Ninth	7	2¼
Fifth	—3⅛	—3⅛			

These three tables show that the dangerous defect noted in 1876, and first measured in 1884, is much reduced at the present date (March, 1886). This improvement has been made by the superintendent of repairs. To counteract this tendency to twist or revolve a frame-work was recommended in the report of 1884 (see drawing B), which was to be erected after the trunk was restored to its vertical position. It permits the passage of canal-boats over the aqueduct. Two have been erected, one on pier 3, the other on pier 6. One should be placed at the center of each span, if the bridge is to be permanently maintained.

Settlement of the arch-ribs.—The superintendent states that the top of the arch-ribs was about 3 inches below the top of the chord when first completed. No measurements, however, were kept.

The following observations are interesting as data for further comparison.

The table shows the number of inches that the top of the arch is vertically below the top of the chord, and also the difference between the observations of 1884 and 1886:

Number of arch.	Down-stream outside arch-rib.				Up-stream outside arch-rib.			
	Top of arch below top of chord.		Settlement.		Top of arch below top of chord.		Settlement.	
	1884.	1886.	1884.	1886.	1884.	1886.	1884.	1886.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
First	6	6¼	3	3¼	8	8⅛	5	5⅛
Second	7	8½	4	5½	3	3	0	0
Third	6	6	3	3	5	6¼	2	3¼
Fourth	2	3½	−1	½	6	7¼	3	4¼
Fifth	6	6	3	3	7	7	4	4
Sixth	4⅛	5⅝	1⅛	2⅝	8	8	5	5
Seventh	4	6⅞	1	3⅞	7	8	4	5
Eighth	6	9⅛	3	6⅛	4	5⅞	1	2⅞
Ninth	11⅛	16	8⅛	13	13	14⅛	10	11⅛

It would not be safe to predicate any statement upon the above table, since the reference plane of the arches is not known with certainty. The settlement of all the arches appears to average about 4 inches, and the arch of the ninth span seems to have settled the most. Since 1884 the actual settlement has been 1½ inches in the up-stream arch and 4½ inches in the down-stream arch. The effect of this difference in the altitude of the arches must be to engender unequal strains, which, however, do not appear to be of sufficient value to endanger their stability.

Remarks on the arches.—It was originally intended that the arches should convey the strains directly to the piers; as constructed, however, each arch abuts against the arch of the next span, and any derangement in one or inequality in the force is conveyed through the series. The effect of unequal forces is apparent upon the heel-plates between two successive arches. In cases where the decayed rib-pieces have given way the plate is much bent by the abutting end of the opposite and undecayed arch.

Addition of arch-ribs.—It is said that the truss was originally designed to sustain the entire load, and that the arch was afterwards added under the following conditions:

When the water was first let into the trough the angle-blocks gave way; new angle-blocks were substituted, and arch-ribs were then added. If this statement is correct, the arch-ribs must have been added before the inspection made by Major Michler, for this officer mentioned them in 1869. The arch-ribs and truss are now necessary to support the entire weight of the aqueduct and moving load. The actual assistance rendered by the arch-ribs and the trusses depends on the relative degree to which the vertical rods pertaining to each are screwed up. The entire load may be divided between the truss and the arch, or may be thrown upon either; but it would not be safe, at the present time, to trust the load to the support of the truss alone or of the arch alone when the water is in the aqueduct.

Defect of arch-ribs.—When constructed it was found necessary to cut the upper part of the ribs to admit the washers, nuts, and ends of the cross rods connecting the upper chords at the middle of the spans. The upper pieces of the outer ribs were also cut into to provide a horizontal seat for the blocks upon which the washers of the suspending rods rest, thus reducing the effective cross-section of the arch timbers.

Masonry of piers.—The piers, completed about the year 1839, are in good condition. A certain amount of deterioration was observed and noted, but it was not measured. It consists in the removal of the cement from between the joints of the ice-breakers, and also from the joints on each side of the piers. This defect is progressive, and although it may be some years before danger can be apprehended from this cause, the repairs should be thoroughly made and at an early date.

VIRGINIA APPROACH.

This approach is composed of bents, or trestles, extending to a crib abutment; each bent is formed of a ground-sill, three posts, and a cap, supporting a roadway. The distance from the end of the aqueduct to the abutment on the road is 447 feet. These trestles have been repaired since the examination made in 1884, and may be considered to be in a fair condition. Some few rotten timbers, posts, and floor-beams should be replaced.

It is evident from the above examination that the two approaches can be easily repaired, and that the division which should be carefully considered is the aqueduct proper.

Before the Senate inquiry can be answered the ability of this part of the bridge to resist the strain to which it is subject should be carefully determined by calculation.

CALCULATION OF STRESSES ON THE TRUSS AND ARCH OF AQUEDUCT BRIDGE.

The calculation of the strength will be made on three hypotheses:

First. That the truss sustains the permanent and moving loads.

Second. That the arch sustains the permanent and moving loads.

Third. A brief consideration of the part which arch and truss perform in supporting the permanent and moving loads.

(1) THAT THE TRUSS SUSTAINS THE ENTIRE LOAD, PERMANENT AND MOVING.

Since January 9, 1869, the date of the certificate of the Chief of Engineers, the bridge has been in continuous use. During the progress of repairs the water is drawn from the aqueduct; the upper deck is still used for ordinary travel. Five years after its completion the first repairs are said to have been made; since this time the work has been annually repeated. It is therefore proper to recalculate the stresses which the bridge was designed to resist and those to which it is now subject, in order to ascertain its present strength.

From the examination just made it is evident that the repairs which have been made annually for the past ten or twelve years have not been co-extensive with the decay, and that a progressive deterioration is noticeable throughout the structure. The new pieces of scantling which have been substituted for the old differ not only in dimension but often in the kind of timber employed.

Kind of timber.—The kind of timber used cannot be ascertained with precision. At the present time the different kinds are distributed nearly as follows: The chords contain about equal quantities of Georgia and North Carolina pine; the main braces are composed of four-tenths of Georgia, and the remaining six-tenths are divided between North Carolina and white pine; the lateral and counter braces are wholly of white pine; the floor beams of the aqueduct are of Georgia pine, and the flooring is of Virginia pine; the floor of the highway bridge is also of Virginia pine. The arches are of white pine, and the skew-backs on each wide pier are of Georgia pine. The weight of the different kinds of timber used in the bridge, distributed as above, has been carefully determined.

Weight of structure per panel.—The weights per square foot are as follows:

Kind of material.	Weight per cubic foot.	Kind of material.	Weight per cubic foot.
	Pounds.		*Pounds.*
Kyanized timber	44.6	North Carolina pine	34.3
Georgia pine	38.5	Virginia pine	34.3
White pine	25.0	Water-soaked pine	45.0

The weight of the structure per panel, based on the above weights, is 36,400 pounds.

Weight of water per panel.—The dimensions of the aqueduct, taken from the original drawing and used in the calculations made in 1884, are less than those determined by measurement. This has been caused by the pressure of the water, which has increased the width and depth of the aqueduct, and has caused it to sag in the middle of each span. The height of the water varies on different days, being greatest on Sunday, and its weight varies with the amount of sedimentary matter held in solution. Taking the dimensions found by measurement, and 62½ pounds as the weight per cubic foot, the weight of water per panel is about 88,000 pounds. By employing this weight the factor of safety will be reduced.

Weight of moving load per panel.—About this weight engineers, theoretical and practical, differ in opinion; a difference due to the estimation of the weight which the bridge may be called on to support.

The roadway of the Aqueduct bridge is often crowded with spectators who have collected to view a boat race. It would not therefore be safe to assume a load less than 90 pounds per square foot, or nearly 1 ton per running foot. This is substantially the same weight as that recommended by a committee of the American Society of Civil Engineers. (See vol. 4 Transactions, page 124.) With this weight the load of each panel will be 27,000 pounds. It is safe to assume that the timber of the truss and arch has an ultimate compressive strength of 3,333 pounds per square inch and an ultimate tensile strength of 7,500 pounds per square inch.

UP-STREAM TRUSS.

The following dimensions have been taken:

Length of truss	feet	111.33
Length of panel	do	12.37
Height between center of upper and lower chords	do	21.92
Width between center of chords	do	25.50
Width of roadway	do	24.30
Number of panels in span		9

The following weights have been taken:

Weight of water per panel	pounds	88,000
Weight of structure per panel	do	36,400
Weight of living or moving load per panel	do	27,000
Total weight of structure, permanent and moving loads	do	151,400

Tangent, .564; secant, 1.148.

The total is greater than that assumed in 1884, the excess being due to the larger amount of water in the aqueduct, which will have the effect of slightly reducing the factors of safety. The center of gravity of the Aqueduct Bridge, on account of the position of the trough, acts upon the up-stream side with a leverage of 1.3 feet; and the top and bottom chord of each panel on this side will be called on to support 83,420 pounds. The load on each panel of this truss will, therefore, exceed the load on the down-stream side by 15,440 pounds.

The weight of 83,420 pounds must be unequally divided between the top and bottom chord, the top chord supporting 22,020 pounds (nearly equal to the moving load), and the bottom chord supporting 61,400 pounds (not quite three-fourths of the weight of water).

The total load, moving and permanent (151,400 pounds), is divided between the upper and lower chord of each panel as follows:

Weight per panel divided between chords and trusses.

Member.	Up-stream truss.	Down-stream truss.	Total on chords of up and down stream truss.
	Pounds.	*Pounds.*	*Pounds.*
Upper chord	22,020	17,944	39,964
Lower chord	61,400	50,036	111,436
Totals	83,420	67,980	151,400

In this truss the compression of the top chord and the tension of the bottom chord are greatest at the central panel, and the greatest strain on the braces is found next to the abutments.

These parts will now be considered, and as the strength of the bridge depends on its weakest member, the strain which such member bears will be given.

The permanent and moving loads will first be considered as a permanent load only, of 151,400 pounds.

The timber being *assumed* as sound, the stresses on the chords and braces will be as follows (Shreve and Humber):

Chords of up-stream truss.—The greatest stress in either chord is found in the middle of the panel, and is made up of the transverse stress of the moment of rupture of the beam added to the compression in the top chord, and to the tensile stress in the bottom chord, in order to determine the entire stress in either of these chords.

This rule, recommended by Trautwine (ed. 1885, p. 498) and based on the experiments of Hodgkinson, depends on the fact that in the Howe truss the load is equally distributed along the chord, and is not, as in iron bridges, concentrated at the panel points.

In the top chord the central panel will be subject to a compressive stress of 470,487 pounds, which, added to the transverse stress of the moment of rupture, 34,048 pounds, will give, after deducting for knots, defects in the timber, and in seasoning, a factor of safety of 1.46.

In the bottom chord the central panel will be subject to the tension of 470,487 pounds, which, added to the transverse stress of the moment of rupture, 94,940 pounds, will, after the reduction of the constant for knots, seasoning, kind of timber, &c. (Trautwine, ed. 1885, pp. 463 and 493), give a factor of safety of 2.28.

Braces of up-stream truss.—The formula used at the present time to determine the strength of braces is that of Gordon, or of Shaler Smith, and is based on the experiments of Hodgkinson, reported between 1840 and 1857 (Trautwine, ed. 1885, p. 458). By these writers the brace is treated as a pillar subject to flexure under pressure.

The two braces at 2–3 or at 17–18 are subject to a compression of 383,064 pounds on an area of 288 square inches; treated as a pillar, according to the formula of Shaler Smith, the two weakest braces combined give a factor of safety of 1.06.

Tie-rods of the up-stream truss.—The three tie-rods at 3–4 or at 17–18 are subject to a tension of 26,128 pounds per square inch, which gives $\frac{40320}{26128}$ pounds—a factor of safety of 1.54 (Trautwine, ed. 1885, p. 408). The three tie-rods at 5–6 or at 15–16 have a factor of safety of 1.66. These rods are still sound and have outlived the wooden parts of the bridge, which have been repaired annually for ten or twelve years.

DOWN-STREAM TRUSS.

This truss will be called on to bear a load, permanent and moving, equal to 151,400 — 83,420 = 67,980 pounds, which will be divided between the top and bottom chords; the top chord supporting 17,944 pounds, and the bottom chord supporting 50,036 pounds.

The factors of safety of this truss, computed by the same formula, are larger than the factors of the up-stream truss, and need not be further considered.

The same remark applies to the factors of safety of the tie-rods.

MOVING LOAD.

(1) *When the aqueduct contains water.*—The effect of the passage of canal-boats cannot be easily determined. The water will be displaced as the boat enters and the wave which follows will increase the load on the bridge in a small degree.

The effect of the moving load of 27,000 pounds upon the deck is more easily determined, but its effect is neutralized by the inertia of the water.

(2) *When the water is withdrawn.*—In this case the factor of safety in the top chord is 3.10, but in the lower chord the stress becomes tensile, and gives a factor of safety of 8.2.

The counter-braces have sufficient strength except in the central panels, but are inefficient or lacking in the first, fourth, fifth, seventh, and ninth spans, and are defective in all the other spans.

The main braces next to the abutment will sustain a stress of 145,566 pounds, which gives a factor of safety of 2.8. The factor of safety of the three tie-rods at one point, either 3–4 or 17–18, is 4.5.

The main braces are the weakest parts, yet when the timber *was in sound condition* they supported the load without danger, although the factor of safety is unusually small.

(2) THAT THE ARCH SUSTAINS THE PERMANENT AND MOVING LOADS.

The space between two piers may be generally described as being spanned by a Howe truss and an arch. To speak accurately, however, the space between two piers is spanned by two trusses and four arch-ribs, one arch-rib on each side of each truss. Each arch-rib is composed of four pieces, hewed to the curve, except the up-stream arch-rib, which has five pieces. (See drawing A.)

The arch-ribs are independent of the trusses, that is, no connection is made between them by bolts, ties, or struts. The truss supports the roadway upon its upper chords, and the aqueduct upon its lower chords; the arch lends its aid to support the truss with its entire load by means of carriage-blocks, which are suspended beneath the lower chords by rods. (See drawing A.) The arch is therefore auxiliary to the truss. These carriage-blocks were originally beams which extended beneath the two lower chords of the truss, but were subsequently cut to afford room for the introduction of the straining beams beneath the aqueduct.

UP-STREAM ARCH.

The following data are employed:

Span of arch	feet	117.00
Distance of center of gravity of half truss	do	27.83¼
Distance from center of pressure of skew-back to center of pressure of crown	feet	18.00
Cross-section of arch in middle of span	square inches	810.00
Cross-section of arch at skew-back	do	810.00
Load on span	pounds	750,780
Pressure at crown of arch	do	610,009
Pressure at skew-back	do	716,260
Factor of safety at crown, in arch as originally constructed		4.42
Factor of safety at skew-back, in arch as originally constructed		3.77

(Humber's Handy Book, page. 48.)

The suspension rods have a factor of safety of 2.45.

On account of decay 450 square inches should be deducted from the sectional area of the two arch-ribs in the up-stream arch of the fourth span, leaving an available cross-section of 360 square inches, which will have a factor of safety of 1.67. This arch is the weakest at the present time in the bridge.

In four of the arch-ribs, viz, the first, seventh, eighth, and ninth, the sectional area should be reduced on account of decay by deducting 270 square inches, leaving an available sectional area of 540 square inches, which will have a factor of safety of 2.51. These factors of the arch are based on an ultimate crushing strength of 3,333 pounds per square inch.

As the up-stream arch is called on to bear the greater weight it should be the stronger of the two.

(3) CONSIDERATION OF THE PART WHICH ARCH AND TRUSS PERFORM IN SUPPORTING THE PERMANENT AND MOVING LOADS.

The two systems must now be considered as acting together and jointly supporting the load which rests primarily upon the truss.

The resistance which each system can offer has been determined by calculation, but it is not practicable to proportion the resistance which each should actually offer to sustain a given load. The adjustment of resistances between the two systems must be left to the judgment of the superintendent. He can determine which must be the greater, but cannot determine its value in pounds or in tons.

The combination of truss and arch as it exists in the Aqueduct Bridge was employed in wooden bridges designed as late as 1870. While it affords certain facilities for making repairs it does not admit, in construction, of that economy of material which is desirable in bridges built of iron or steel.

The method employed to obtain the results given below will be found in Haupt on Bridge Construction, page 189.

The following data have been used, and all calculations refer to the up-stream truss.

(1) *Top chord.*—The area of the top chord is taken at 266 square inches and results from deducting the decayed timber actually observed. The chord is calculated as a pillar by Shaler Smith's formula, and a deduction of one-third is made for knots, crooked grain, &c., as recommended by Trautwine (edition 1885, page 493.)

(2) *Bottom chord.*—The area of the bottom chord, after deducting for decayed timber actually observed, is 259 square inches. The constant for transverse strength is reduced one-third as recommended by Trautwine (edition 1885, page 493), and the constant for tensile strength is reduced one-fourth, as recommended by the same author (edition 1885, page 463).

(3) *Braces.*—The area of the braces next to the abutment is 288 square inches. Shaler Smith's formula is employed, and no deduction is made from the constants other than that included in the formula (Trautwine, edition 1885, page 458). The combined action of the truss and arch is calculated according to Haupt (Bridge Construction, page 188).

(4) *Arches.*—The area of the two arch-ribs, after deducting the decay actually observed, is 360 square inches at the skew-back. The constant of compression reduced one-third, according to Trautwine, will be 3,333 pounds per square inch.

(5) *Suspension and tie-rods.*—The average breaking strength assumed is that recommended by Trautwine, which varies from 40,320 pounds per square inch for rods 2¼ inches in diameter to 42,560 pounds per square inch for rods 1¾ inches in diameter.

With the above data the following factors of safety have been determined:

For the top chord	2.35
For the bottom chord	2.47
For the braces	2.82
For the arch at skew-back	4.91
For suspension and tie rods	2.20

The tie-rods exhibit no appearance of deterioration, although they have been in use for seventeen years, during which time the wooden parts have been renewed ten or twelve times.

The factor of safety of the arch at skew-back is double that of the suspension and tie-rods together. The excess may be designed to prevent any change in the form of the arch.

With moderate yet sufficient strength when originally constructed, the aqueduct lacks cross-bracing necessary to give rigidity and to resist the tendency to revolve on its horizontal axis. To prevent this tendency a system of cross-bracing was recommended in 1884, but was not carried out. It is shown in drawing B, and is designed so as to leave an unobstructed way for the canal-boats. One of these frames should be placed at the center of each span.

From the above table of factors the weakest part of the bridge appears to be in the top chord, the factor of safety in which is 2.35 when the sectional area to which the formula applies is in *sound condition.*

GENERAL CONCLUSIONS.

The following conclusions are drawn from the report of inspection and from the calculation above given:

Approaches.—The two approaches can be put in a satisfactory condition by replacing with sound timber the decayed parts mentioned in the foregoing report of inspection.

Aqueduct proper.—The Aqueduct Bridge when the water is withdrawn can be made safe for the passage of persons, animals, and vehicles by the completion of the following repairs:

All decayed and defective timber should be replaced by sound timber of the proper dimensions. The floor, floor-beams, and much of the old trunk can be removed.

The straining beams and substruts will not be needed and should be replaced by the lateral braces. The counter-braces now wanting in the central panels of each span should be supplied. The old kyanized struts against the sides of the aqueduct are in good condition, but should be properly fitted into new floor-beams placed beneath the aqueduct.

The old flooring of the roadway should be replaced by a new flooring.

The trusses and the arches should be restored to their original vertical position, and should be maintained by diagonal ties. Braces can be added if necessary. (See drawing B.)

Many of the carriage-blocks in each span are defective or useless. The efficiency of the arch depends on the condition of these blocks, and forty-five have been counted which should be at once renewed.

The chords and parts most liable to decay should be kyanized or covered with zinc.

After the completion of the repairs the bridge should be properly adjusted by screwing the nuts of the tie-rods, and unremitting attention should be given to the maintenance of the proper adjustment of the load upon the trusses and arches.

When the bridge is repaired further settlement of the arch may be prevented by replacing the old timbers with new of exactly the same dimensions and by employing heart pine for the skew-back and the part of the arch adjacent thereto. Iron plates should be employed at the abutting ends of the arch-ribs.

Kyanized timber used by Captain Turnbull.—The duration of kyanized timber is of sufficient importance to be placed upon record. A fragment of kyanized wood used by Captain Turnbull is in my possession. It weighs 44.6 pounds per cubic foot, and is in perfect condition. Its age can be nearly determined. The last date in the journal which was kept during the construction of the piers is December 16, 1837. Assuming that the wooden trough was completed three years later, the specimen in my office will be forty-six years old in December, 1886.

The distinguished engineer James B. Francis testifies to the superior value of the *Kyan* process.

ANSWER TO THE SENATE RESOLUTION.

The answer to the Senate resolution of February 25, 1886, will be found in the foregoing report of examination, which gives the condition of the Aqueduct Bridge on the 16th day of March, 1886.

Coefficients have been established by the authorities on bridge building which represent the proportion that the ultimate strength of materials bears to the strain which can safely be brought upon them. Humber, one of the approved authorities on the subject, for permanent load upon wooden structures, gives a factor of safety ranging from 4 to 5.

The strength of a bridge is determined by its weakest part. The factor of safety of the weakest part of the Aqueduct Bridge is found in the top chord, in which the coefficient is 2.35 when the bridge is loaded with water and with the moving load. It is therefore evident that when thus loaded the bridge cannot be pronounced to be safe for a moving load of 90 pounds per square foot, and that, for the security of ordinary travel, thorough repairs and unceasing diligence will be necessary to prevent accident.

I am indebted to the courtesy of Mr. W. W. Dungan, representing the lessees, for the offer of every facility for making a thorough examination of the bridge.

Very respectfully, your obedient servant,

S. T. ABERT,
United States Agent.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

APPENDIX K.

IMPROVEMENT OF THE HARBOR AT NORFOLK, VIRGINIA; APPROACH TO NORFOLK HARBOR, VIRGINIA; CURRITUCK SOUND, COANJOK AND EDENTON BAYS, AND NORTH RIVER BAR, NORTH CAROLINA—IMPROVEMENT OF CERTAIN RIVERS IN VIRGINIA AND NORTH CAROLINA.

REPORT OF CAPTAIN F. A. HINMAN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Harbor at Norfolk, Virginia.
2. Approach to Norfolk Harbor and the United States (Norfolk) Navy-Yard, between Lambert's Point and Fort Norfolk, Virginia.
3. Appomattox River, Virginia.
4. Nottoway River, Virginia.
5. Blackwater River, Virginia.
6. Archer's Hope River, Virginia.
7. North Landing River, Virginia and North Carolina.
8. Edenton Bay, North Carolina.
9. Currituck Sound, Coanjok Bay, and North River Bar, North Carolina.
10. Meherrin River, North Carolina.
11. Pamplico and Tar rivers, North Carolina.
12. Yadkin River, North Carolina.
13. Scuppernong River, North Carolina.
14. Removing sunken vessels or craft obstructing or endangering navigation.

UNITED STATES ENGINEER OFFICE,
Norfolk, Va., July 22, 1886.

GENERAL: I have the honor to transmit herewith my annual report upon the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1886.

Very respectfully, your obedient servant,

F. A. HINMAN,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

K 1.

IMPROVEMENT OF HARBOR AT NORFOLK, VIRGINIA.

There were no operations during the fiscal year ending June 30, 1886, the funds available not being sufficient to justify any. The small amount expended during that time was for contingencies.

The condition of the work on June 30, 1886, was as stated in the Annual Report for 1885, with slight deterioration. The ruling depth is 24 feet at mean low water. This information is necessarily based on a cursory examination, no survey having been made since that of March and April, 1885.

The easterly side of the cut through Sewall's Point Bar should be buoyed every 1,200 feet to mark it properly.

The portion of the approach to the harbor between Lambert's Point and Fort Norfolk is not included herein, as it is now a work by itself.

A plan and specifications have been prepared for building a suitable steam tender to replace one that has been chartered for a number of years past for use in this district. It will be built in due time and paid for from allotments from this and other works. The estimated cost is $8,000.

The funds available will be applied to contingencies.

The sum of $507,744.56 can be profitably expended in the fiscal year ending June 30, 1888, with which it is proposed to complete the improvement as projected (for details see Report of the Chief of Engineers, 1885), to the great benefit of navigation, commerce, and to the United States (Norfolk) navy-yard.

The commercial statistics relative to exports, imports, cotton, and coal are appended hereto. There is no organization that collects statistics relating to truck, oysters, lumber, peanuts, &c., which are certainly large.

Norfolk is a port of entry.

Money statement.

July 1, 1885, amount available	$2,000 94
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	113 53
July 1, 1886, amount available	1,887 41
Amount appropriated by act approved August 5, 1886	50,000 00
Amount available for fiscal year ending June 30, 1887	51,887 41
Amount (estimated) required for completion of existing project	457,744 56
Amount that can be profitably expended in fiscal year ending June 30, 1888	457,744 56
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Statistics relative to port of Norfolk, Va., for the fiscal year ending June 30, 1886, *received from W. R. Mayo, esq., collector.*

Articles.	Quantities.	Values.
IMPORTS.		
Salt .... pounds..	19,614,527	$42,744
Superphosphate ... tons..	900	11,096
Kainit .... do...	999	7,232
Guano .... do...	1,054	61,514
Coal .... do...	255	520
Potatoes .... bushels..	11,091	2,115
Wine .... gallons..	852	597
Olive oil .... do....	10	4
Coffee .... pounds..	170	17
Maccaroni .... do....	100	5
Works of art............	....	1,465
Cotton-plush frames......	....	49
Conch shells	....	3
Olives	....	30
Total	....	127,391
EXPORTS.		
Cotton .... bales..	245,606	11,167,860
Staves .... number..	4,510,443	230,561
Logs .... do ...	6,716	73,240
W. O. plank .... do....	8,324	28,562
EXPORTS—continued.		
Shingles .... number..	545,300	$4,456
Poplar plank ...... do....	1,830	2,220
Shuttle blocks ..... do....	30,000	1,000
White-oak spokes .. do....	6,590	230
Plank .... do....	759	400
Boat .... do....	1	150
Church bell .... do....	1	50
Grindstones .... do....	390	90
Cartridges .... do....	2,000	44
Muskets .... do....	2	32
Cotton ties .... do....	37,000	1,000
Coal .... tons..	25,964	70,788
Manganese .... do...	334	8,390
Pyrites .... do...	259	5,180
Corn .... bushels..	53,021	30,745
Bark .... bags..	4,951	5,074
Grain bags ..... number..	5,975	472
Tobacco .... pounds..	107,729	10,618
Pine plank .... feet..	356,565	5,030
Shuttle blocks .... cases..	431	715
Wine .... gallons..	10	10
Total............	....	11,646,917

Vessels cleared and entered.

Direction.	Cleared.		Entered.	
	Number.	Tonnage.	Number.	Tonnage.
Foreign	159	141,913	82	67,168
Coastwise	1,555	1,334,537	1,398	1,215,398
Total	1,714	1,486,450	1,480	1,282,566

LETTER OF THE NORFOLK AND PORTSMOUTH COTTON EXCHANGE.

NORFOLK AND PORTSMOUTH COTTON EXCHANGE,
Norfolk, Va., July 13, 1886.

DEAR SIR: Herewith please find statement receipts and shipments of cotton at the port of Norfolk for twelve months ending 30th June, 1886.

RECEIPTS.

	Bales.
Received at Norfolk, 12 months. ending 30th June, 1866	562,053

SHIPMENTS.

	Bales.	
Exported direct to Great Britain	235,402	
Exported direct to France	2,328	
Exported direct to the Continent	7,878	
Total exports		245,608
Coastwise—New York, Boston, Providence, Baltimore, and Philadelphia		310,867
Total shipments twelve months, 30th June, 1886		556,475

Since the organization of our exchange in 1874 there have been received and shipped to 30th June following number of bales of cotton:

	Bales.
Receipts twelve years to 30th June, 1886	6,671,379
Shipments twelve years to 30th June, 1886	6,660,672

I remain, dear sir, yours, very truly,

NORMAN BELL,
Superintendent and Secretary.

Capt. F. A. HINMAN,
Corps of Engineers, U. S. A.

STATEMENT OF RECEIPTS AND SHIPMENTS OF COTTON AT THE PORT OF NORFOLK, VIRGINIA.

NORFOLK AND PORTSMOUTH COTTON EXCHANGE,
SUPERINTENDENT'S OFFICE,
Norfolk, Va., August 31, 1885.

GENTLEMEN: Herewith I have the honor to submit the eleventh annual statement of the cotton movement of the port of Norfolk for the twelve months ending August 31, 1885—season of 1884-'85.

The movement, owing to the shortness of the crop, has not equaled that of the previous year, but notwithstanding this the direct exports show a material increase during the same period, thus demonstrating that the reputation of the port, both as a market and a shipping point, has been well maintained in the leading cotton marts of Great Britain and the Continent.

The splendid facilities for the handling and shipment of cotton which have signalized this port, through its powerful compresses and its magnificent coastwise lines of steamships, have been further augmented by the opening of the New York, Philadelphia and Norfolk Railroad, which commenced operations in November last.

The movement of cotton at the ports of Virginia has attained such volume that I beg to direct your attention to a summary of the same, both at West Point and Newport News, and which will be found further on in this report. In the Newport News report will be found 6,137 bales which have been ferried to Norfolk and exported through our custom-house.

	Bales.
Norfolk has handled	548,823
West Point has handled	211,753
Newport News has handled	58,712
Total handled at three Virginia ports	819,288

The receipts and shipments of cotton at the port of Norfolk for the twelve months ending August 31, 1885, are as follows:

RECEIPTS.

Route.		Through.	Local.	Total.
Norfolk and Western Railroad		85,676	140,397	226,073
Seaboard and Roanoke Railroad		60,647	158,024	218,671
Norfolk Southern Railroad		11,505	41,067	52,572
Chesapeake and Ohio Railroad		6,137	614	6,751
Albemarle and Chesapeake Canal		3,810	43,693	47,503
Dismal Swamp Canal		....	757	757
Nansemond and James Rivers, &c		....	2,633	2,633
Total receipts for Norfolk		167,775	387,185	554,960
Deduct received from Wilmington	2,384	8,521	....	....
Deduct received from Newport News	6,137			
Deduct received from Mobile, Ala	800	....	1,021	9,542
Deduct received from Charleston, S. C	221			
Receipts at Norfolk		159,254	386,164	545,418

RECEIPTS IN ELEVEN YEARS.

Receipts season 1884–'85	159,254	386,164	545,418
Receipts ten years previous	2,815,495	2,751,332	5,566,827
Receipts in eleven years	2,974,749	3,137,496	6,112,245

EXPORTS AND SHIPMENTS.

The direct exports, coastwise shipments, and other details of the distribution of the movement are as follows:

		Bales.
Exported direct to Great Britain since September 1, 1884		277,667
Exported direct to France		6,375
Exported direct to Continent		11,775
Total direct foreign exports		295,817
Coastwise movement:		
New York	90,846	
Boston	74,506	
Providence	31,172	
Baltimore	46,571	
Philadelphia	13,301	
Liverpool, via Newport News	593	
Total coastwise shipments		256,989
Total shipments		552,806
Withdrawn for consumption since February 1, 1885	642	
Burned February 25, 1885	1,968	
Shipped overland to Petersburg and Suffolk	399	
		3,009
Total distribution		555,815

RECAPITULATION.

	Bales.
By stock on hand August 31, 1884	930
By total receipts 12 months ending August 31, 1884	554,960

	Bales.	
To direct exports	295,817	
To coastwise shipments	256,989	
To consumption, burned and overland	3,009	
To stock on hand August 31, 1885	125	
Total		555,940

Following is a summary of the exports and shipments from this port for the past eleven years:

	Foreign.	Coastwise.	Total.
Shipments, 12 months August 31, 1885	295,817	256,989	552 806
Shipments, 10 years ending August 31, 1884	2,187,083	3,367,894	5,554,977
Total	2,482,900	3,624,883	6,107,783

The value of our direct exports for season 1884-'85 amount to $14,279,835, an increase of $2,697,010 over the season of 1883-'84, and for the past seven seasons are as follows:

Season.	Bales.	Value.
1878-'79	203,596	$9,143,015
1879-'80	257,085	13,785,209
1880-'81	328,818	17,286,947
1881-'82	331,817	17,578,410
1882-'83	372,529	17,869,682
1883-'84	248,361	11,582,825
1884-'85	295,817	14,279,835

There have been shipped on through bills of lading to Great Britain and the Continent, via Boston, New York, Philadelphia, and Baltimore, 65,917 bales, exclusive of 593 bales shipped via Newport News to Liverpool. These shipments do not appear as our exports, being credited at port where finally cleared.

The shipments via coastwise lines on through bills of lading for the past seven seasons have been as follows:

Season.	Bales.	Season.		Bales.
1878-'79	30,270	1882-'83		91,288
1879-'80	25,614	1883-'84		82,818
1880-'81	40,873	1884-'85	65,917	66,510
1881-'82	42,749	Liverpool via Newport News	593	

Through the courtesy of P. H. Adams, Esq., General C. and F. Agent at West Point, Va., I am enabled to give the receipts and shipments of cotton at that port.

Receipts at West Point, Va., twelve months ending August 31, 1885			211,753
Exported to Great Britain (Liverpool)	12,762		
Exported to continent	13,895		
Total direct exports		26,657	
Coastwise shipments:			
New England towns	26,636		
New York	105,728		
Philadelphia	12,411		
Baltimore	40,294		
Returned home	27		
Total domestic movement		185,096	
Total amount, West Point			211,753

Through the published figures I am enabled to give following statement of movement of cotton at Newport News for twelve months ending August 31, 1885, and to Hon. Baker P. Lee, collector of customs, I am indebted for the official exports of cotton for same period:

Gross receipts at Newport News for twelve months ending August 31, 1885	59,316
Less cotton direct for Norfolk and ferried to destination	614
Net receipts, Newport News	58,702

DISTRIBUTION.

Exported direct to Liverpool, as per custom-house returns	22,976
Ferried to Norfolk, for export to Liverpool	6,137
Shipped to coastwise ports, New England towns, &c	29,589
Total	58,702

I desire to express my appreciation of the courtesies extended this office by the officials and their representatives of the various transportation lines, and also the honorable collector of the port.

I remain, dear sirs, very respectfully, your obedient servant,

NORMAN BELL,
Superintendent and Secretary.

The PRESIDENT AND BOARD OF DIRECTORS,
Norfolk and Portsmouth Cotton Exchange.

Statement of Pocahontas semi-bituminous coal delivered at Lambert's Point Pier and Norfolk, Va., from July 1, 1885, *to June* 30, 1886.

Month.	Steamers loaded or supplied.			American sailing vessels loaded.					Total vessels.	Tons of coal shipped or supplied.				
	British.	Spanish.	Norwegian.	Ships.	Barks.	Barkentines.	Brigs.	Schooners.		Foreign.	Coastwise.	Steamers.	Local.	Total.
July	....	....	....	1	....	....	....	43	44	*2,501	24,536	....	1,863	28,900
August	....	....	....	....	....	....	1	42	43	601	28,853	....	2,370	31,824
September	2	1	....	....	....	....	1	39	43	480	24,633	638	2,220	27,971
October	8	....	....	....	....	....	1	44	53	159	27,324	1,899	4,069	33,451
November	6	....	....	....	....	....	....	40	46	....	26,862	1,579	4,518	32,959
December	11	....	....	....	....	1	1	42	55	2,184	25,956	2,882	3,723	34,745
January	7	....	....	....	....	2	....	37	46	2,430	24,233	1,402	4,172	32,237
February	4	1	....	....	....	....	1	17	23	2,274	10,314	1,207	3,786	17,581
March	11	....	....	....	....	1	1	49	62	1,691	37,842	3,181	6,161	48,825
April	8	1	1	....	1	....	....	51	62	408	43,356	2,422	6,214	52,400
May	3	2	....	....	....	....	2	48	55	2,291	40,023	1,363	6,674	50,351
June	2	....	....	....	1	1	3	43	50	1,984	28,491	477	3,854	†34,806
Total	62	5	1	1	2	5	11	495	582	17,003	342,423	17,000	49,634	426,059

*Cargo of ship John Bryce shipped to San Francisco, Cal.
†Changing gauge of Norfolk & Western railroad affected receipts temporarily.

WILLIAM LAMB & CO.,
Agents of Castner & Co., Limited,
Norfolk, Va., June 30, 1886.

Capt. F. A. HINMAN,
Corps of Engineers, U. S. A.

K 2.

IMPROVEMENT OF APPROACH TO NORFOLK HARBOR AND THE UNITED STATES (NORFOLK) NAVY-YARD BETWEEN LAMBERT'S POINT AND FORT NORFOLK, VIRGINIA.

The act of July 5, 1884, appropriated $50,000 specifically to widen the channel of this portion of Elizabeth River. A Board of Engineer Officers was convened August, 1884, to prepare a project for the application of this appropriation, and submitted reports thereon. (For details see Report of the Chief of Engineers, 1885.) The Board reported a plan involving, in conjunction with dredging, the construction of a dike at or near Pinner Point, expressing at the same time doubts whether, under the phraseology of the law, any part of the money could be applied to a work of construction.

However, the requirements of navigation demanding the widening of the channel as contemplated in the project already commenced and partly executed by dredging, it was recommended that the existing appropriation be applied to widening the channel between Lambert's Point and Fort Norfolk by dredging along the eastern side thereof.

This having been duly approved, proposals were invited for dredging in accordance therewith, and on August 12, 1885, a contract was entered into with P. Sanford Ross, esq., the lowest bidder, to do the work at 9⅜ cents per cubic yard, measured in scows.

Mr. Ross began work October 1, 1885, and completed it December 22, 1885, nine days sooner than the least time (three months) allowed by the contract for its execution. He removed 469,944 cubic yards of material, about 300,000 cubic yards of which was deposited on Craney Island Flats and the balance in Willoughby Bay.

This work has resulted in a straight channel at least 25 feet deep and not less than 400 feet wide at mean low water the entire length of this approach, which formerly had an angle in it.

It has given greater safety and ease to navigation, and promoted and facilitated commerce, trade, the postal service, and the business relating to the navy-yard.

The easterly side of the channel should be buoyed every 1,200 feet to mark it properly.

A plan and specifications have been prepared for building a steam tender for use on this and other works. For details relative thereto see report for this fiscal year on harbor at Norfolk, Va., and its approaches.

The funds available will be applied to contingencies. The sum of $255,600 can be profitably expended in the fiscal year ending June 30, 1888, with which it is proposed to complete the improvement as projected (for details see Report of the Chief of Engineers, 1885,) to the great benefit of navigation and commerce, and also the United States (Norfolk) navy-yard.

For commercial statistics see report of this fiscal year on harbor at Norfolk, Va., and its approaches, of which this is a part.

Norfolk is a port of entry.

Money statement.

July 1, 1885, amount available	$49,618 64
Amount received from an officer for fuel	38 25
	49,656 89
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	46,806 89
July 1, 1886, amount available	2,850 00
Amount appropriated by act approved August 5, 1886	137,500 00
Amount available for fiscal year ending June 30, 1888	140,350 00
Amount (estimated) required for completion of existing project	118,100 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	118,100 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals received for dredging approach to Norfolk Harbor and the United States (Norfolk) navy-yard, opened by Capt. F. A. Hinman, Corps of Engineers, at Norfolk, Va., August 7, 1885.

No.	Names and addresses of bidders.	Date of commencement and completion of work.	Number and kind of machines to be used.	Capacity (cubic yards per day).	Price per cubic yard.
					Cents.
1	Daniel Constantine, president Baltimore Dredging Company, Baltimore, Md.	Commence work about October 15, 1885, and complete same on or about January 1, 1886.	A sufficient number of clam-shell dredges.	....	10.1
2	American Dredging Company, Isaac Albertson president, Philadelphia, Pa.	According to specifications.	All necessary machinery and appliances.	....	9.7
3	Morris & Cumings Dredging Company, by Joseph Cumings president, New York, N. Y.	Commence work within forty days and complete same by January 1, 1886.	Two or more clam-shell machines.	4,000	9.875
4	Rittenhouse Moore, Mobile, Ala.	According to specifications.	One large clam-shell dredge.	4,000	13.3
5	P. Sanford Ross, Jersey City, N. J.	Commence work October 1, 1885.	Two large clam shell dredges.	4,000	9.375
6	National Dredging Company, George G. Barker treasurer, Wilmington, Del.	Commence work on or before October 1, 1885.	Two or more grapple dredges.	4,000	10.375
7	New York Steam Dredging Company, S. F. Shortland president, New York, N. Y.	Commence work on or before October 1, 1885, and complete same on or before January 1, 1886.	Two large clam-shell dredges.	4,000	12

Contract with P. Sanford Ross.

K 3.

IMPROVEMENT OF APPOMATTOX RIVER, VIRGINIA.

The operations during the fiscal year ending June 30, 1886, were confined to Puddledock Cut.

The contract with A. F. Hall, esq., referred to in the last Annual Report, was duly extended to and completed on January 15, 1886. Mr. Hall removed 70,124 cubic yards of material, measured in place, making a total of 121,424 cubic yards removed under his contract.

Seven pile and brush revetments, aggregating 940 linear feet, were built by hired labor, the purchase of material in open market, and the use of the United States plant, to sustain the dredge bank at weak points on the westerly side of the cut.

The foregoing has resulted in materially widening and deepening the channel along the entire length (about 2 miles) of the westerly side of Puddledock Cut, and also along 1,250 linear feet of the easterly side, thereby subserving navigation and commerce. The navigable channel through this cut is not less than 60 feet wide at bottom and at least 12 feet deep at high water.

The condition of the work on June 30, 1886, was good. There was a navigable channel at least 12 feet deep at mean high water, except at a few points where short shoals have formed with 11 feet thereon. It is believed that this is due either to the untimely departure or arrival of vessels, or to the overloading or careless handling of them, which causes them to ground and form shoals. This practice should of course be discontinued.

The outlet into Old Channel will be closed as soon as Puddledock Cut is completed; this will tend to remove the shoal that forms in that vicinity, at Jetty 22.

The small balance available will be applied to the care of property and contingencies. The sum of $46,000 can be profitably expended in the fiscal year ending June 30, 1888, with which it is proposed to complete the improvement as projected, to the great benefit of navigation and commerce. It is estimated that $5,000 will be required yearly thereafter to maintain the work, parts of which are of a temporary character and will need repairs.

The commercial statistics are appended hereto.

Petersburg is a port of entry.

Money statement.

July 1, 1885, amount available		$10,437 09
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$9,519 79	
July 1, 1866, outstanding liabilities	60 00	
		9,579 79
July 1, 1886, amount available		857 30
Amount appropriated by act approved August 5, 1886		18,750 00
Amount available for fiscal year ending June 30, 1887		19,607 30
Amount (estimated) required for completion of existing project		27,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		27,250 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

PETERSBURG, *July* 14, 1886.

DEAR SIR: In compliance with your request of June 28 last, I hereby furnish you statistical information of the tonnage and commerce of the port of Petersburg for the fiscal year 1885–1886. Table A represents the tonnage of the port for the period named. Table B shows the articles of freight received at or sent from the port by way of Appomattox River, with the values thereof, at the city of Petersburg during the year ending June 30, 1886.

TABLE A.—*Tonnage of the port of Petersburg, from July* 1, 1885, *to July* 1, 1886.

Class.	Vessels.	Tonnage.
Schooners	229	24,962 56
Sloops	58	605 79
Steam-tugs	345	4,075 18
Steamers	321	39,192 13
Total	953	68,835 66

TABLE B.—*River commerce of the port of Petersburg.—Value of articles of freight.*

INWARD FREIGHT.

Articles.	Value.	Articles.	Value.
Coal	$77,420	Peanuts	$24,501
Corn	9,111	Potatoes	3,800
Oats	936	Oil	6,550
Wheat	430	Bricks	2,148
Hay, straw, &c	1,576	Cabbages	400
Ice	32,604	Sumac	1,875
Guano	219,312	Lumber, pine	1,830
Lime, builder's	1,620	Lumber, white pine	455
Lime, shell	1,000	Oysters	2,750
Salt, Liverpool and G. A	1,001	Miscellaneous	5,000
Cotton ties	14,426		
Cotton	65,505	Total	474,250

OUTWARD FREIGHT.

Barrels	$994	Lumber, pine	$49,492
Cotton	42,850	Wood, pine	38,178
Cotton seed	420	Wood, poplar	4,411
Gas tar	1,449	Miscellaneous	40,000
Guano	14,480		
Stable manure	279	Total	192,053

SUMMARY.

Inward commerce	$474,250
Outward commerce	192,053
Total	666,303

The past fiscal year, like the one immediately preceding, proved to be a dull one in trade, and whilst Table A will show an increase in the tonnage of the port as compared with that of 1884–1885, there has been considerable falling off in the commerce by the river.

In my last annual report it was stated that negotiations were pending for the removal of certain rocks in the harbor, and it is a matter of satisfaction to communicate the fact of the accomplishment of this work, a depth of 12 feet at low tide having been made at the three points where the said rocks existed; and the bar made by the spring freshets in the basin cut out by the Government some time ago was dredged out by the city in June, but which has since been formed again by the heaviest flood that has occurred in the Appomattox Rixer for about thirty-five years, it being over a foot below the height attained by the great freshet of March, 1851; the said shoal will no doubt be again cleared away this summer.

The city has likewise carried on dredging operations during the year, in the removal of bars at the Magazine Reach, near the corporation line, and at the head of Puddledock Cut, which obstructed the navigation no little and tended to impair the commerce of the port; and this last-named bar has formed again and is the shallowest part of the entire channel at this date. Now the original scheme of a navigable channel-way of 12 feet at mean high tide is most anxiously looked for to be brought about at an early day, which will be sure to augment the tonnage and commerce of the port, and prove to be the dawning of an auspicious era in the commercial history of Petersburg.

The following statistics are taken from the official records of the United States internal revenue department of Petersburg for the year 1885.

Tax collected from tobacco manufactured in Petersburg		$344,624 80
Tobacco manufactured in Petersburg, exported	pounds..	4,840,120

Very respectfully,

E. H. STAINBACK,
Port Warden.

Capt. F. A. HINMAN,
Corps of Engineers, U. S. A.

K 4.

IMPROVEMENT OF NOTTOWAY RIVER, VIRGINIA.

There were no operations during the fiscal year ending June 30, 1886. It was deemed inexpedient to resume them, the funds available being insufficient. The small amount expended during that time was for contingencies.

There are no reliable commercial statistics available. There is but little traffic over the river. No further appropriation is asked for this work.

This river is in the collection district of Norfolk, Va.

Money statement.

July 1, 1885, amount available	$453 29
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	207 13
July 1, 1886, amount available	246 16

K 5.

IMPROVEMENT OF BLACKWATER RIVER, VIRGINIA.

There were no operations during the fiscal year ending June 30, 1886, there being no funds available.

The sum of $2,500 can be profitably expended in the fiscal year ending June 30, 1888. It is proposed to apply this as follows:

Redredging two bars that have shoaled slightly, cutting off projecting points that have only been partially cut off, and removing any logs, snags, &c., that may be found.

The commercial statistics are appended hereto.
This river is in the collection district of Norfolk, Va.

Money statement.

Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	$2,500 00

COMMERCIAL STATISTICS.

Business delivered to and from points on Chowan, Blackwater, and Meherrin rivers, by Albemarle Steam Navigation Company, from July 1, 1885, *to July* 1, 1886.

Articles.		North.	South.
Merchandise	pounds	5,285,958	11,902,768
Guano	do		4,206,840
Cotton	bales	12,372	
Fish, fresh	boxes	2,780	
Fish, salt	barrels	4,006	

No business from Nottoway River.

J. H. BOGART,
Superintendent Albemarle Steam Navigation Company.

Capt. F. A. HINMAN,
Corps of Engineers, U. S. A.

K 6.

IMPROVEMENT OF ARCHER'S HOPE RIVER, VIRGINIA.

There were no operations during the fiscal year ending June 30, 1886. It was deemed inexpedient to resume them, the funds available being insufficient. The small amount expended during that time was for contingencies.

The amount that can be profitably expended in the fiscal year ending June 30, 1888, is $9,400.70. This will be applied to dredging and will complete the project.

No reliable commercial statistics are available. However, they are unimportant.

This river is in the collection district of Yorktown, Va.

Money statement.

July 1, 1885, amount available	$45 96
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	25 33
July 1, 1886, amount available	20 63
Amount (estimated) required for completion of existing project	9,400 70
Amount that can be profitably expended in fiscal year ending June 30, 1888	9,400 70
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

K 7.

IMPROVEMENT OF NORTH LANDING RIVER, VIRGINIA AND NORTH CAROLINA.

There were no operations during the fiscal year ending June 30, 1886. It was deemed inexpedient to resume them, the funds available being insufficient. The amount expended during that time was for contingencies and the construction of a combined steam hoister and pile-driver for use on this work, and also on the Pamplico and Tar rivers. For the details relative thereto, see report for this fiscal year on the latter.

The funds available will be applied to contingencies. The sum of $10,000 can be profitably expended in the fiscal year ending June 30, 1888. It is proposed to apply this to dredging, as set forth in the Annual Report of the Chief of Engineers, 1885, and also to the removal of logs, &c., that have made their appearance since the river was last cleared of them. The most of this is due to the careless handling of log-rafts, for which there should be some remedy.

The commercial statistics received from the Albemarle and Chesapeake Canal Company are appended hereto. They also relate to Currituck Sound, Coanjok Bay, and North River Bar, which are on the same inland water route.

This river is in the collection district of Norfolk, Va.

Money statement.

July 1, 1885, amount available	$1,701 28
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	201 28
July 1, 1886, amount available	1,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	10,000 00

COMMERCIAL STATISTICS.

Trade through the Albemarle and Chesapeake Canal for fiscal year ending June 30, 1886, *passing through Elizabeth and North Landing rivers.*

GOING NORTH.

Articles.	Quantity.	Articles.	Quantity.
Cotton .... bales..	58, 478	Rice .... bushels..	29, 688
Fish .... barrels..	1, 609	Wheat .... do....	3, 060
Naval stores .... do ...	2, 576	Peanuts .... bags..	4, 924
Rags .... pounds..	2, 250	Lumber .... feet..	70, 885, 312
Old iron .... do....	6, 400	Railroad ties .... number..	10, 283
Bacon .... do....	24	Watermelons .... do....	298, 946
Eggs .... crates..	1, 990	Shingles .... do....	26, 106, 488
Wood .... cords..	222	Staves .... do....	496, 102
Peas and beans .... bushels..	4, 513	Laths .... do....	738, 075
Potatoes .... do....	51, 041	Passengers .... do....	1, 752
Corn .... do....	97, 028		

GOING SOUTH.

Articles.	Quantity.	Articles.	Quantity.
Bread .... barrels..	49	Soap and candles .... boxes..	127
Beef and pork .... do....	8, 400	Tobacco .... do....	482
Cider and beer .... do....	6	Ware .... crates..	17
Flour .... do....	33, 537	Lime and cement .... casks..	888
Fish .... do....	538	Oyster shells .... bushels..	54, 155
Molasses .... do....	645	Agricultural lime .... do....	35, 475
Spirits .... do....	529	Iron .... pounds..	640, 420
Sugar .... do....	2, 656	Hay .... bales..	11, 447
Oil .... do....	2, 384	Guano .... tons..	4, 783
Coffee .... sacks..	319	Coal .... do....	3, 552
Salt .... do....	8, 266	Ice .... do....	1, 561
Hats and shoes .... cases..	119	Passengers .... number..	1, 589
Nails .... kegs..	388		

K 8.

IMPROVEMENT OF EDENTON BAY, NORTH CAROLINA.

The operations during the fiscal year ending June 30, 1886, were confined to dredging.

The contract with Thomas P. Morgan, esq., referred to in the last Annual Report, was completed August 27, 1885. The total quantity of material removed under it is 46,043 cubic yards, measured in situ; deducting therefrom the approximate estimate, 29,000 cubic yards, removed last year, leaves 17,043 for this year. Four hundred and ninety pounds of No. 2 dynamite was purchased in open market and used here by the Government in blasting stumps, &c., to facilitate dredging.

The accompanying map of the last survey of this locality, made September 7–10, 1885, shows that the work has resulted in a channel, the entire length and depth projected, 150 feet wide at the outer end and 165 feet wide at the inner end, with a triangular turning-basin midway of 9½ acres. The total area dredged here is 17½ acres; and the total 9 feet deep and upward at ordinary low water, 18¾ acres. There is a navigable channel of varying width at least 10 feet deep, at same stage, the entire length of the harbor.

The funds available will be held for contingencies. The balance of the estimate required for the completion of the adopted project is $8,000, but no further appropriation is asked for at present as Edenton has a harbor amply sufficient for all the present wants of navigation and commerce, which, so far as can be forecast, will suffice for some time to come. It is probable that dredging will be required at long intervals, as the bay has a tendency to silt slowly.

The commercial statistics received from M. K. King, esq., general manager of the Norfolk Southern Railroad, are appended hereto. There are more of minor importance, but they could not be obtained.

Edenton is in the collection district of Albemarle, N. C.

Money statement.

July 1, 1885, amount available	$3,742 63
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,295 22
July 1, 1886, amount available	447 41
Amount appropriated by act approved August 5, 1886	2,000 00
Amount available for fiscal year ending June 30, 1887	2,447 41
Amount (estimated) required for completion of existing project	6,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

[Norfolk Southern Railroad Company, General Manager's Office.]

NORFOLK, VA., *July* 13, 1886.

DEAR SIR: Inclosed please find the statistics requested in your letter of June 28.

Very truly,

M. K. KING,
General Manager.

Capt. F. A. HINMAN,
Corps of Engineers, U. S. A.

Character and quantity of freight north bound from Roanoke River, Edenton, and Scuppernong River, transported by Norfolk Southern Railroad from July 1, 1885, *to July* 1, 1886.

Articles and tonnage.	Edenton and Roanoke River.	Scuppernong River.	Articles and tonnage.	Edenton and Roanoke River.	Scuppernong River.
ARTICLES.			ARTICLES—continued.		
Lumber..........feet..	280,100	7,634	Staves........number..	11,969	....
Corn..........bushels..	168	7,091	Shingles..........do....	200,850	....
Rice..........do....	1,842	6,230	Barrel heads......do....	99,450	....
Truck..........packages..	9,994	3,151	Sheep and hogs...do....	27	50
Fish, fresh........boxes..	5,216	496	Peanuts.......bushels..	19,528	1,77
Fish, salt........barrels..	1,782	240	Logs..........feet..	2,982,026	2,10
Tar and rosin.......do....	97	....	TONNAGE.		
Cotton..........bales..	12,649	1,793			
Melons..........number..	15,040	....			
Cattle..........do....	40	364	North bound..........	30,738,472	3,066,42
Poultry..........crates..	69	856	South bound..........	13,171,945	2,226,2
Eggs..........do....	1,092	1,989			
Merchandise ..packages..	3,914	1,501	Total..........	43,910,417	5,292,6

K 9.

PROVEMENT OF CURRITUCK SOUND, COANJOK BAY, AND NORTH RIVER BAR, NORTH CAROLINA.

There were no operations during the fiscal year ending June 30, 1886. t was deemed inexpedient to resume them, the funds available being sufficient.

The channel has deteriorated some, due very largely, it is thought, to teamers grounding out of it and creating shoals in their efforts to get f. Buoys or piles maintained constantly between the gas-beacons to ark the channel would tend to diminish this.

A plan and specifications have been prepared for building a steam-ender for use on this and other works. For the details relative thereto, ee report of this fiscal year on harbor at Norfolk and its approaches, Virginia.

The funds available will be applied to contingencies. The sum of $65,122.85 can be profitably expended in the fiscal year ending June 30, 1888. It is proposed to apply this to dredging, as set forth in the Annual Report of the Chief of Engineers, 1885.

The commercial statistics are the same as those to be found in report on North Landing River for this fiscal year, these works being on the ame inland water route.

Currituck Sound, Coanjok Bay, and North River Bar are in the collection district of Norfolk, Va.

Money statement.

July 1, 1885, amount available	$1,500 00
July 1, 1886, amount available	1,500 00
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	11,500 00
Amount (estimated) required for completion of existing project	55,122 85
Amount that can be profitably expended in fiscal year ending June 30, 1888	55,122 85
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

K 10.

IMPROVEMENT OF MEHERRIN RIVER, NORTH CAROLINA.

There were no operations during the fiscal year ending June 30, 1886. It was deemed inexpedient to resume them, the funds available being insufficient to do necessary dredging. The small amount expended during that time was for contingencies. The balance available will doubtless be required in due time to remove logs, snags, &c., that will have again formed obstructions.

The sum of $7,500 can be profitably expended in the fiscal year ending June 30, 1888. It is proposed to apply this to dredging and the removal of obstructions like those above that will continue to form.

A portion of the commercial statistics will be found in report for this fiscal year on the Blackwater River. There are more, as other lines of boats ply here, but they could not be obtained.

The Meherrin River is in the collection district of Norfolk, Va.

Money statement.

July 1, 1885, amount available	$447 60
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	32 13
July 1, 1886, amount available	415 47
Amount (estimated) required for completion of existing project	7,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	7,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

K 11.

IMPROVEMENT OF PAMPLICO AND TAR RIVERS, NORTH CAROLINA.

The combined steam-hoister and pile-driver referred to in the last Annual Report was completed for use on this work and North Landing River. The cost of this as per original specifications was $4,063.57. Extras, in the shape of outfit, &c., were added, making the cost $4,538.05. From August 19 to October 31 it was engaged in removing obstructions, and thoroughly cleared the river of them between Washington and Greenville. (The portion worked over is the first 6½ miles below Greenville.) It is well adapted to the work. Six hundred and eighty-three obstructions were removed and burnt, so that they can never again enter the river during freshets as obstructions. They consisted of the following: 2 sunken flats, 29 floating logs, 228 sunken logs, 128 sunken trees, 25 stumps, 249 snags, and 22 overhanging trees.

An examination of the river was made, which shows it to be in the following condition: Of the forty-one jetties twenty-five were in good order, and the balance not. As a rule they have proved of benefit to navigation, but more will be required to complete the project. Some have been damaged by steamers striking them at high water, for which reason piles should be placed at the ends thereof to mark them. The best jetties are those composed of two rows of piles, filled in with logs, &c. No work has been done on jetties since 1882. There are yet many overhanging trees along this river, and many logs, snags, &c., to be removed. The bridges at Greenville and Sparta collect large quantities of drift, which causes shoals and rapids to form to the detriment of navigation. Clear span-bridges should be substituted therefor. Steamers run regularly from Washington to Greenville the year round, and thence to Tarborough only during high water.

The foregoing was done by the hire of labor, the purchase of material in open market, and the use of the United States plant.

The small balance available will be applied to the care of property and contingencies.

The sum of $5,000 can be profitably expended in the fiscal year ending June 30, 1888. It is proposed to apply this to the removal of logs, snags, shoals, &c., and the repair and construction of jetties.

The commercial statistics, collected from three steamship companies, &c., by Mr. F. B. Satchwell, Washington, N. C., are appended hereto. There are more of minor importance, but they could not be obtained.

These rivers are in the collection district of Pamplico, N. C.

Money statement.

July 1, 1885, amount available	$2,462 90
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,414 23
July 1, 1886, amount available	48 67
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,048 67
Amount that can be profitably expended in fiscal year ending June 30, 1888 submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	5,000 00

COMMERCIAL STATISTICS.

Receipts and shipments.

Articles.	Quantities.	Articles.	Quantities.
Lumber ....feet..	8,317,444	Potatoes ....barrels..	6,415
Shingles ....number..	2,887,825	Merchandise ....packages..	11,192
Staves ....do....	111,800	Peas ....bags..	208
Cotton ....bales..	27,804	Green hides ....number..	38
Rice ....bushels..	17,000	Balusters ....do....	41,950
Naval stores ....barrels..	6,140	Tonnage ....tons..	807,165

K 12.

IMPROVEMENT OF YADKIN RIVER, NORTH CAROLINA.

Operations were resumed August 15 and suspended November 21. High water greatly interfered with the work. It was unusually high several times during the year. The work consisted in extending the channel, at winter stage, around the north end of Swicegood's Mill-dam and into the pool above it, without injuring the water-power, but on the contrary improving it incidentally. This was accomplished by executing the following in addition to that given in the last Annual Report: Six wing-dams, aggregating 356 linear feet, and two sill-dams, 60 linear feet each were built; one wing-dam was extended 5 linear feet; the training-wall was extended 125 linear feet above the mill-dam; 150 linear feet of training-wall and 498 linear feet of wing-dams, built in 1884, were raised and strengthened, and several rock ledges removed.

In the prosecution of the above, 325 linear feet of holes were drilled, and two hundred and seventy-five blasts made, using 615 pounds of No. 2 dynamite. The following material was consumed by the work: 445 cubic yards of rock, 300 cords loose brush, twenty-seven brush mattresses, 20 feet long, 10 feet wide, and 1½ and 2 feet thick, and thirty-eight logs.

The foregoing was done by the hire of labor, the purchase of material in open market, and the use of the United States plant.

The condition of the work on June 30, 1886, was excellent, it being of a very permanent nature. The plant generally has been in use since the fall of 1880. It has received current repairs as needed, but will require extensive repairs and renewals ere long.

The act of July 5, 1884, provided as follows:

> That the sum of $6,000, authorized by the act approved June 14, 1880, to be expended for the removal of dams in Yadkin River, North Carolina, may be used by the Secretary of War for acquiring the right of way, by removal or otherwise, of such dams as may be necessary for the contemplated improvement, the said right of way or removal to be obtained by agreement with the parties interested, or, in event of failure to make a reasonable agreement, by condemnation, as provided for by the laws of the State of North Carolina.

It is questionable whether the expenditure of any of this sum will be necessary, as recent investigations show that the dams can all be best and most economically passed by wing-dams and training-walls, or by locks, as the case may be. Accordingly, this amount will be held for the present. It would be very expensive to make low-water navigation on this river in any manner; the commerce to be developed would not justify it.

On June 20, 1885, the Chief of Engineers approved the recommendation made in the project submitted January 6, 1885, that the balance of the funds available, aside from the $6,000 reserved for acquiring the right of way by removal or otherwise of dams, be applied to improving the river at Swicegood's Mill Dam, Dutchman's Island, Boone's Ford Shoal, reef below Fulton, Peebles' Dam, Peebles' Reef, and Hartley's Dam, in the order named, for navigation at *winter stage.* The balance available will be applied accordingly, as heretofore.

The sum of $10,000 can be profitably expended in the fiscal year ending June 30, 1888. It is proposed to expend this in lengthening and further improving the channel at winter stage.

No commerce existed upon the river before the commencement of the improvement, and none has been developed thus far. The commercial statistics, furnished by Mr. Frank Brown, overseer, are appended hereto.

This river is in the collection district of Wilmington, N. C.

Money statement.

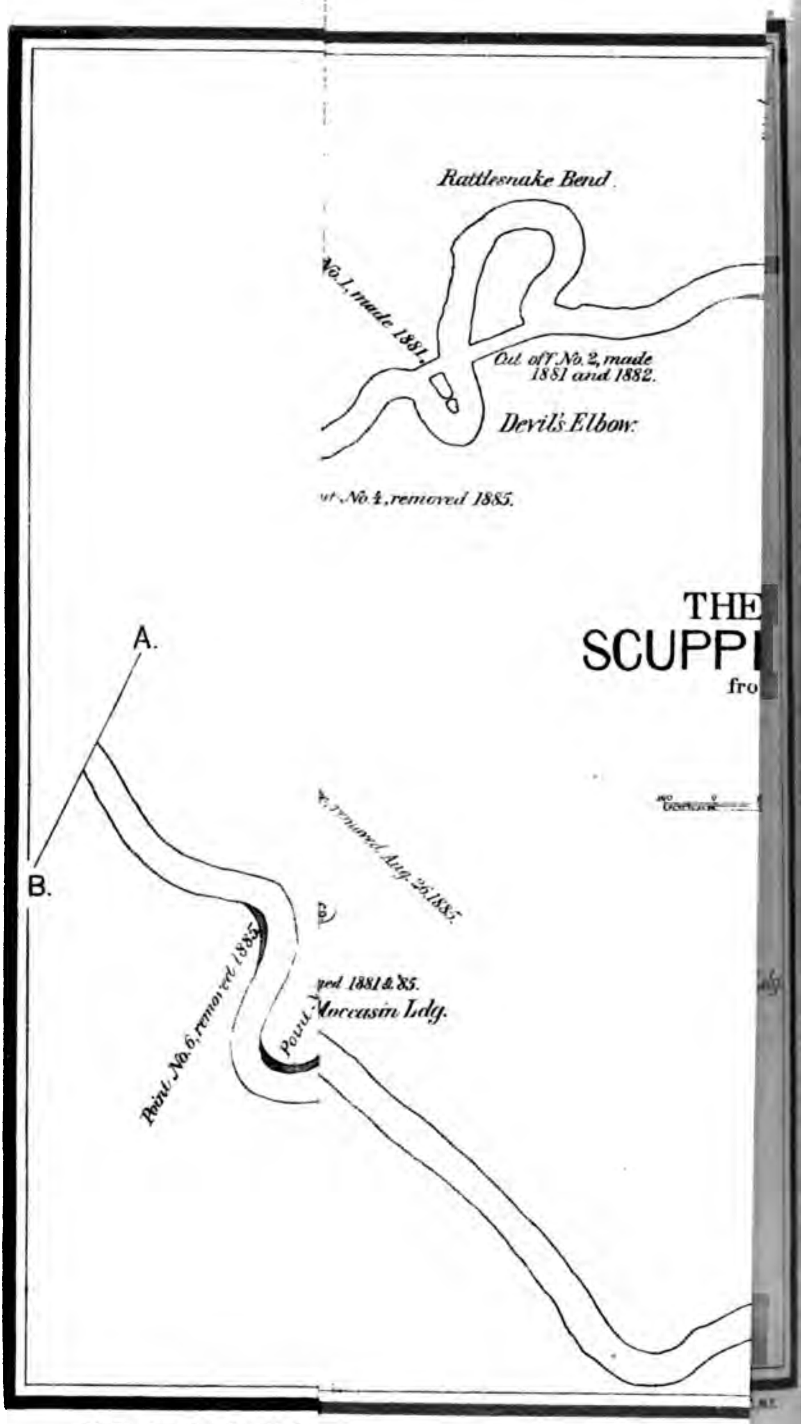
July 1, 1885, amount available	$14,723 95
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	6,339 85
July 1, 1886, amount available	8,384 10
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	18,384 10
Amount that can be profitably expended in fiscal year ending June 30, 1888. Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	10,000 00

COMMERCIAL STATISTICS.

FORK CHURCH, DAVIE COUNTY, N. C.,
July 8, 1886.

CAPTAIN: In compliance with your request of the 28th ultimo, I have the honor to make the following statement in reference to the commercial statistics of that section of country lying along and contiguous to the Yadkin River.

I respectfully state that these statistics have been gathered from my own books (farming, as you know, about 10,000 acres) and from reliable farmers above and below me on the river. Owing to the long-continued rainy season, it is my candid opinion that one-half of the wheat crop will be lost. Oats unusually good.



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ral products of above-named section for fiscal year ending June 30, 1886:

Articles.	Quantity.	Articles.	Quantity.
...............bushels..	500,000	Oats.......................bushels..	56,500
..................do....	101,000	Tobacco....................pounds..	3,200,000
..................do....	5,636	Cotton.......................bales..	1,600

respectfully, your obedient servant,

FRANK BROWN,
Overseer.

A. HINMAN,
orps of Engineers, U. S. A.

K 13.

ROVEMENT OF SCUPPERNONG RIVER, NORTH CAROLINA.

operations were resumed July 20, 1885, and completed Sep-
, 1885. The accompanying map shows where the work was
ll dredging was to 9 feet at low water, the details of which are
:
No. 3 widened 12 feet, making it 100 feet long and 40 feet wide.
No. 4 was made; it is 136 feet long and 40 feet wide.
oroughfare was widened 15 feet, making it 50 feet long and
55 feet wide.
oints were rounded off; the number of feet removed from each,
from the point back, is as follows: No. 1, 32 feet; No. 2, 24
3, 22 feet; No. 4, 28 feet; No. 5, 15 feet; No. 6, 17 feet; No.
No. 8, 18 feet.
ning-basin at the head of navigation was sufficiently enlarged
off Point No. 1 and dredging an area 15 feet by 40 feet on
ite side.
-foot shoal, 650 feet long, at the mouth of Collins Canal (outlet
helps) was removed.
egoing was done by the hire of labor and machinery and the
of material in open market, and occupied a dredge 525 work-
. Three hundred and twenty pounds of No. 2 dynamite was
last roots and stumps; the number of blasts made being 129,
ge of about 2.5 pounds to each blast.
eamboat men are greatly pleased with the work, as it has bene-
igation in a very marked manner, by not only shortening the
about half a mile, but also by saving almost endless trouble and
e in pasing bends, permitting larger loads, lessening danger,
ng the handling of steamers, &c. So far as can be foreseen
urther work will be required on this river for many years, as it
t that its navigable condition is amply sufficient for the trade

is really no organization that collects commercial statistics.
, two steamers run regularly on the river and do an extensive
, one of them running to Elizabeth City, N. C., under the man-
of the Norfolk Southern Railroad. Other vessels run on the
sionally. The commercial statistics received from M. K. King,

esq., general manager of the Norfolk Southern Railroad, will be found in report on Edenton Bay for this fiscal year.

This river is in the collection district of Albemarle, N. C.

Money statement.

July 1, 1885, amount available	$1,879 33
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,879 33

K 14.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

(1) *The schooner Lawrence.*—This wreck (referred to in the last Annual Report) lay in the Scuppernong River near Spruill's Bridge, North Carolina (see accompanying map). Not being removed by the owner thereof after lawful notice, she was accordingly raised and floated on August 26 last, by the Government. Her dimensions were 60 feet by 16 feet. An attempt was made to keep her afloat in order to sell her according to law, but it being ascertained that the cost thereof would be greatly in excess of her value, being old, rotten, and almost worthless, the schooner was accordingly moved a short distance and allowed to sink where she would be out of the way. This has finally disposed of her very effectually and cheaply, the cost thereof being $100, which was the estimate.

(2) *The barge Albemarle.*—This barge was formerly the side-wheel steamer Albemarle, built and owned by the Old Dominion Steamship Company; she was then 165 feet long, 33 feet beam, and 19 feet in the hold. While in tow of the tug Minnie, on December 11 last, she sprung a leak in a gale and sunk in 7½ fathoms of water, with Hog Island light-house bearing west-northwest, distant 5 miles. Her cargo consisted of coal.

It having been represented on December 23 last, that she was directly in the track of vessels bound to or from Chesapeake Bay, and Northern and Eastern ports, and a dangerous obstruction to navigation, a personal examination was made of her, without expense to the Government, on January 22 last, which showed that the late storms had so broken her up and embedded her in the sand (as is usual on this coast) that she had ceased to form such an obstruction as is contemplated by section 4 of the river and harbor act of June 14, 1880.

(3) *The schooner Maria and Elizabeth.*—This schooner was wrecked in the gale of December 9 last. She sunk in 5 fathoms of water, Cape Charles light-house bearing north, distant 3½ miles. Her tonnage was 193 and her cargo consisted of stone and cement. She had been stripped of masts, anchors, &c., by a wrecking company.

The same representation was made of her on December 23 last, that was made of the Albemarle, and she was personally examined on the same day, without cost to the Government, with the same result.

(4) *The schooner Tarry Not.*—This schooner was wrecked in the severe storm of January 9 last. She sunk on Craney Island Flats, Virginia, near the mouth of the Nansemond River. On January 27 last she was reported as being an obstruction to navigation, and in due time thereafter, on February 21 last, a personal examination, made without cost

to the Government, verified the report. Her tonnage was 234, and her cargo consisted of kainit. She had been stripped of everything of value by a wrecking company.

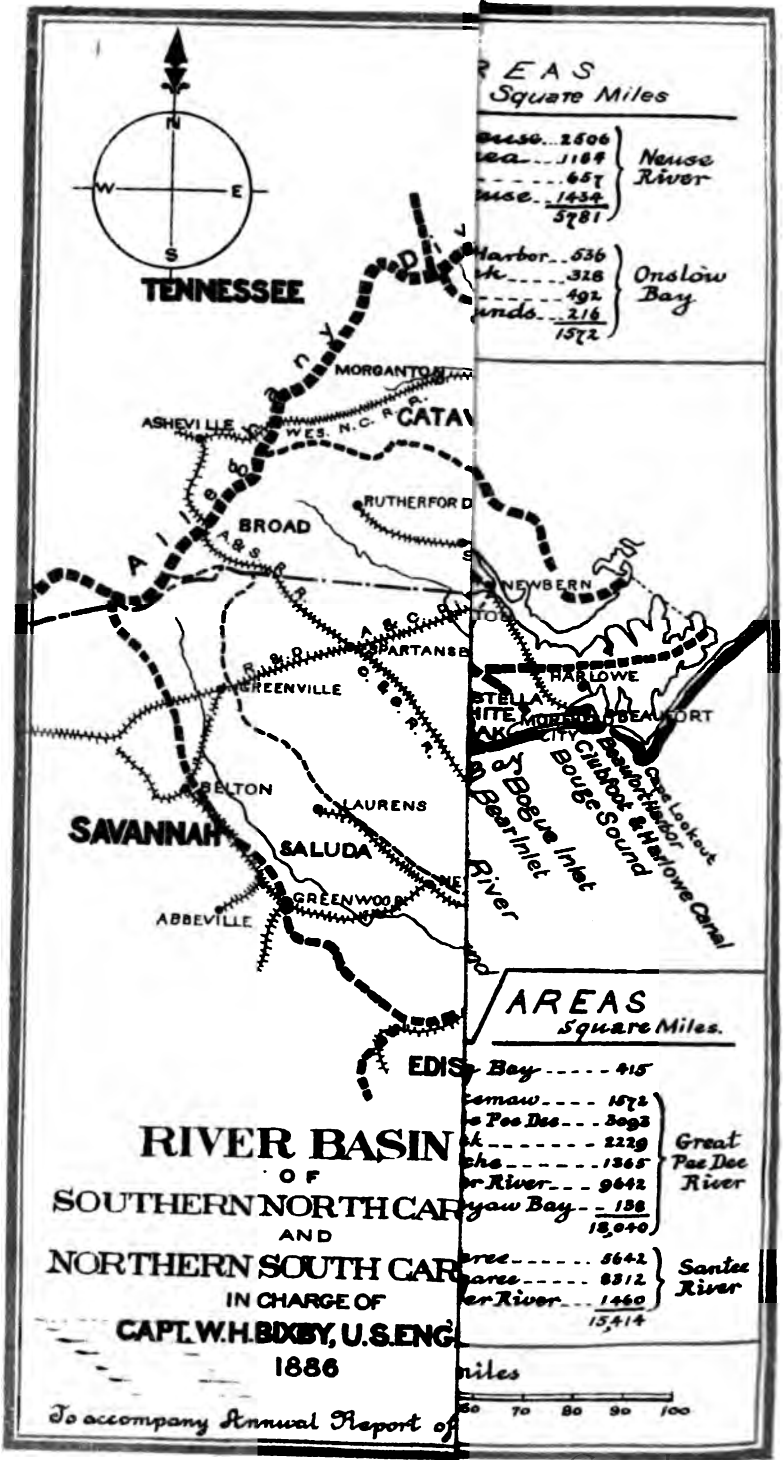
Not being removed by her owner after lawful notice, she was removed by the Government under my personal supervision. The wreck lay on her bottom, embedded somewhat in the mud, in 14 feet of water at low tide, with only 3 feet on part of her. On June 21 last, 240 pounds of dynamite (40 per cent. nitro-glycerine) was divided up and placed close to and around her sides at twelve points. This was fired in two blasts, that destroyed the after part only. On June 23 last, the forward part was annihilated by means of gunpowder, 100 pounds of which was divided up and sealed in four jugs, holding from 20 to 30 pounds each, which were properly placed, one at a time, by a diver, and fired separately by electricity. An examination made thereafter showed that the wreck had ceased to endanger navigation. This work was done at a cost of $428.43. The estimated cost thereof was $500.

(5) *The schooner Anthea Godfrey.*—This wreck was discovered February 8 last, sunk in Lynn Haven Roads, Virginia, in 4½ fathoms of water, Cape Henry light-house bearing E. by S. ¾ S., distant about 6 miles. The crew had perished, and there was a question as to the name of the vessel, but subsequent events have proved almost conclusively that it was the Anthea Godfrey, a schooner of 182 tons, loaded with kainit. She was reported on that date as being a dangerous obstruction to navigation, and in due time thereafter, February 21 last, a personal examination, made without expense to the Government, showed this to be the case. A wrecking company had stripped her of everything of value.

She was duly advertised, and not being removed in due time thereafter, was destroyed by the Government under my personal supervision on June 16 last. She was bottom up, with about 20 feet of water thereon at low tide; by means of a diver 260 pounds of dynamite (40 per cent. nitro-glycerine) was distributed along and fastened to her keel at nine points, and the whole fired simultaneously by electricity. An examination made thereafter showed that the wreck was completely broken up, and had ceased to endanger navigation. This work was done at a cost of $387.37. The estimated cost was $500.

(6) *The steamer Concord.*—This steamer was burned and sunk in the Pamplico River, near Washington, N. C., on February 20 last, on which date an employé of this office reported her a dangerous obstruction to navigation, being barely covered at low water and near the edge of the channel. Her tonnage was 174, and her cargo consisted principally of cotton, some of which has been saved and is of little value. Her machinery may be worth $1,500; her hull is valueless. She has been duly advertised, at an expense of $6, under the law, the notice being dated April 1 last; since then she has been libeled in the United States district court, and advertised to be sold on July 2, 1886. There will be no further operations regarding her until the court has finally disposed of her and the purchaser (if any) has had reasonable time to act thereafter.

All the foregoing work was done by hired labor, the purchase of material in open market, and the use of the United States plant, that being the most economical and advantageous mode of doing it. It is proposed to remove the wreck of the Concord in a similar manner, if it has to be done by the Government. The estimated cost of so doing is $500.



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APPENDIX L.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS OF NORTH CAROLINA AND SOUTH CAROLINA.

REPORT OF CAPTAIN WILLIAM H. BIXBY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, *WITH OTHER DOCUMENTS RELATING TO THE WORK.*

IMPROVEMENTS.

1. Contentnea Creek, North Carolina.
2. Trent River, North Carolina.
3. Neuse River, North Carolina.
4. Inland Navigation from New Berne, to Beaufort Harbor, via Clubfoot, Harlowe, and Newport rivers, North Carolina.
5. Harbor at Beaufort, North Carolina.
6. New River, North Carolina.
7. Cape Fear River, above Wilmington, North Carolina.
8. Cape Fear River, below Wilmington, North Carolina.
9. Great Pe Dee River, South Carolina.
10. Waccemaw River, South Carolina.
11. Harbor at Georgetown, South Carolina.
12. Santee River, South Carolina.
13. Wateree River, South Carolina.
14. Removing sunken vessels obstructing or endangering navigation.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., August 24, 1886.

GENERAL: I have the honor to transmit herewith annual reports for the fiscal year ending June 30, 1886, upon the works of river and harbor improvement then in my charge.

Very respectfully, your obedient servant,

WM. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

L 1.

IMPROVEMENT OF CONTENTNEA CREEK, NORTH CAROLINA.

Contentnea Creek, a tributary of the Neuse River, has a total length of about 144 miles, and a drainage area of 1,184 square miles. This creek, prior to governmental improvement in 1881, had a depth of about 3 feet during nine months of the year, from its mouth in the Neuse upward, about 63 miles, to Stantonsburg, its practical limit of navigation; but its channel was completely blocked at all stages of water by sunken logs and stumps, and by floating obstructions. Its steamboat commerce was nothing.

The original project of 1881, as continued to date, proposed for $40,000 to secure a safe and unobstructed 3-foot navigation over this entire distance during the high-water season of about nine months. This estimate was based on an examination required to be made in great haste, at slight expense, and during a time of high freshet. The estimate supposed the obstructions to be about 17 sunken trees and 1 stump per mile, but actual work has since shown about 45 sunken trees and 45 stumps per mile.

Inadequate yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant, have added considerably to the cost of the work. The aggregate amount appropriated for this project up to 30th June, 1886, is $25,000. The present estimate (that of 1885), $75,000 for the final cost of the work, is based on these later developments.

Twenty-four thousand six hundred and eighty-seven dollars and sixty-nine cents has been spent in all upon this improvement up to 30th June, 1885, in securing a roughly-cleared 3-foot navigation over the 31 miles from its mouth up to Snow Hill, during the high-water season. In consequence of this, a steamboat line has been permanently established upon the whole length thus improved, and two steamboats have made bi-weekly trips during nearly nine months each year, to the great benefit of the neighboring country, otherwise without transportation facilities for its products. The present commerce (including rafted goods) is rapidly increasing, and is at present about $450,000 of goods transported per year; showing that each dollar spent on the improvement has been accompanied by the development of $18 in annual commerce.

The navigation of this river is obstructed at points, as shown by the following extract from special report dated January 17, 1885:

> Between Stantonsburg, the head of present improvement, and Snow Hill, the head of present navigation there are three county bridges without draws, but there has as yet been no navigation demanding draws. When needed, the draws will undoubtedly be put in by the county authorities. I therefore recommend that these bridges be permitted, for the present, to remain in their present condition, provided that their owners will insert suitable draws therein whenever needed by steamers.

The special work of the year is as follows:

Expenditures, $1,419.08.

The amount of money, $1,731.39, available at the commencement of the fiscal year, was too small for economical work; but improvement was so much needed that small immediate actual results were regarded as more valuable than larger, but delayed, possible ones. Owing to its variable features and the difficulty of properly specifying it beforehand and inspecting it afterward, the work was allowably done by hired labor and the purchase of materials in open market.

Work was confined to the lower half mile of river, and could be carried on only at low-water stages. Between the 3d November and 10th December, during a few days in March, and between the last of April and 31st May, 59 logs, 154 stumps, 68 large snags, 32 cords small snags, 35 cubic yards of earth, 230 linear feet of old sheet-pile diking were removed from the river bed; 86 trees, 32 stumps, and 50 linear feet of brush were cut and hauled back from 200 feet of river bank; 342 linear feet of new sheet-pile diking, and 400 linear feet of log-dam were constructed, and 78 linear feet of old sheet-pile diking were repaired. Some of the stumps had to be removed by blasting.

All the above work has been well and vigorously carried forward under the immediate supervision of Assistant Engineer R. Ransom.

A brief history of past work upon this improvement has been prepared by Assistant Engineer R. Ransom, and is herewith appended.

Recommendations for future work are as follows: That this improvement be completed in accordance with the present proposed and approved project, so as to secure a thoroughly-cleared 3-foot navigation over the entire river from its mouth 63 miles upward to Stantonsburg during the nine commercial busy months of the year, at a total expense of $50,000, in addition to the $312.31 available June 30, 1886; this amount to be appropriated in two yearly installments of $30,000 and $20,000, respectively. Smaller appropriations will increase the cost by from $1,000 to $4,000 per appropriation. Further improvement, so as to extend this navigation above Stantonsburg, or so as to make the lower river navigable during the low water season, is not recommended at present.

After the improvement is finished its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement, as regards cost and order of work, should be carried on approximately as follows:

Twenty thousand dollars to secure a fairly-cleared natural channel for steam navigation from Snow Hill 32 miles upward to Stantonsburg, by removing all dangerous obstructions, such as sunken logs and snags, and by cutting down and pulling back from caving banks the trees which would otherwise soon fall into the river. The extension of navigation to Stantonsburg will open up the richest part of the Contentnea Basin and will greatly increase the river commerce.

Ten thousand dollars to dredge and dike the natural channel near the river's mouth, so as to keep the water from running off into the adjacent swamps.

Twenty thousand dollars to clear the entire river thoroughly of all remaining obstructions to its free navigation during the nine commercially busy months of the year.

This river is in the second collection district of North Carolina.

Money statement.

July 1, 1885, amount available		$1,731 39
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,398 67	
July 1, 1886, outstanding liabilities	20 41	
		1,419 08
July 1, 1886, amount available		312 31
Amount appropriated by act approved August 5, 1886		15,000 00
Amount available for fiscal year ending June 30, 1887		15,312 31
Amount (estimated) required for completion of existing project		35,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		30,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

HISTORY OF THE IMPROVEMENT OF CONTENTNEA CREEK, NORTH CAROLINA.

1880–'81. By the river and harbor act of 14th June, 1880, a survey or examination of this stream was ordered. It was made by Mr. Reid Whitford, in January, 1881.

The improvement proposed consisted in the removal of all obstacles in order to secure during the season of flush water 3 feet navigation from its mouth to Stantonsburg, 70 miles above. The estimated cost of such improvement was $40,000. Congress, by act of March 3, 1881, appropriated $10,000 for this work.

1881–'82. On the 14th of September, 1881, work was begun at the mouth and continued with improvised means, cleaning the stream of logs, stumps, &c., only partially for about 4 miles up stream. Within 1¼ miles of the mouth 750 feet of side dams or dikes were put in experimentally. On the 1st January, 1882, the machinery from the Neuse was transferred to this stream, and the work of cleaning the stream and its banks progressed up to within 3 miles of Hookerton. An accurate account of obstructions removed was not kept. On the 22d of March, 1882, work was suspended for want of funds.

1882 and 1883. The river and harbor act of August 2, 1882, appropriated $10,000 for continuing this work, and it was resumed 1st of November, 1882, and by 1st of March, 1883, was carried to Snow Hill, about 45 miles above the mouth, clearing out as the season before. During April and May little was done on account of high water. In June the "Lower Narrows" were greatly improved and a large amount of work done. During the season of 1882–'83 785 logs and 969 small logs and 1,028 stumps were taken from the bed of the stream and 568 large and 3,570 small trees cut from the banks.

1883 and 1884. Only a small amount of the appropriation remained on hand, and the force was kept at work during July, 1883, near the mouth in the "Narrows," and over 250 large stumps with an uncounted number of small ones and "cypress knees" were taken out. Want of funds stopped operations at end of July, 1883.

1884–'85. On August 5, 1884, Congress made a further appropriation of $5,000 to continue this improvement.

On the 1st of December, 1884, a survey by Assistant Engineer J. P. Darling was begun and continued for ten days near the mouth to determine accurately contours, &c. It was discontinued on the 10th of December, 1884, on account of high water, but information of valuable import was obtained. On the 9th of February, 1884, the plant belonging to Neuse River was transferred to this stream, and on 17th of same month work was resumed at Snow Hill and proceeded down-stream over what had been done, and between the 19th of February and 27th of April, 1885, 928 logs and 705 stumps were taken from the bed of the stream and 174 large trees cut from the banks.

1885 and 1886. On the 3d of November, 1885, work was resumed on this stream near the mouth and continued to the 10th of December, 1885, when stopped by high water. In this thirty-seven days 420 linear feet of lumber dikes were put in (342 feet new work and 78 feet repairs); 400 feet of brush and log dam, near head of Spring Slough, was built; 230 feet old dikes removed; 57 trees, 20 logs, and 62¼ cords of brush cut; 450 feet of bank cleared; 59 logs, 52 snags, 14 stumps, 11¼ cords of small stuff, and 35 cubic yards of mud taken out of slough and stream.

R. RANSOM,
Assistant Engineer.

MARCH 25, 1886.

L 2.

IMPROVEMENT OF TRENT RIVER, NORTH CAROLINA.

Trent River, a tributary of the Neuse River, has a total length of about 73 miles, and a drainage area of 657 square miles. This river in 1879, at the time when placed under governmental improvement, possessed a 6-foot to 8-foot roughly cleared navigation from its mouth at New Berne up 21 miles to Pollocksville, and a lighter-draught navigation 9 miles further to Quaker Bridge. Above Pollocksville the bars, snags, and trees prevented all navigation, except occasionally by small flat-boats during high freshets.

Its commerce is estimated to have been about $400,000 of goods per year.

The original projects of 1879 to 1880, as continued to date, assumed that 6 to 8 feet of water could be carried at all stages from its mouth 21 miles to Pollocksville, and proposed for $22,000 to secure a thoroughly cleared 3-foot navigation, with at least 50 feet channel width at all stages of water from Pollocksville 22 miles up to Trenton, the practicable limit of steamboat navigation, using the balance of the funds to improve the channel from its mouth 30 miles upwards to Pollocksville and Quaker Bridge.

This estimate was based on an examination required to be made in great haste and at slight expense. The estimate as regards sunken obstructions in the upper 14 miles of river supposed only 25 stumps and logs per mile, whereas an average of 250 per mile were actually found.

Inadequate yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant, have added considerably to the cost of the work. The aggregate amount appropriated for this project up to 30th June, 1886, is $42,000.

The present estimate (that of 1885), $57,000 for the final cost of the work, is based upon these later developments.

Forty-one thousand four hundred and eighty-nine dollars and six cents has been spent in all upon this improvement up to 30th June, 1886, in securing a moderately well cleared 6-foot to 8-foot navigation at all stages (8 to 9 feet at ordinary stages) from New Berne 30 miles up to Quaker Bridge; and thence a thoroughly cleared 3-foot navigation at least 50 feet wide at all stages 13 miles further to Trenton, and an excellent turning-basin at Trenton. In consequence of this improvement, a steamboat navigation has been permanently established over the entire river to Trenton, with weekly trips in summer and tri-weekly trips in the busy seasons of winter. The commerce is still increasing, and is now about $600,000 of goods transported per year (including rafted goods), showing that each dollar spent on this improvement has been accompanied by the development of about $5 of annual commerce.

The navigation of this river is not obstructed by bridges without draws.

The special work of the year is as follows:

Expenditures, $159.50.

Owing to the small amount of available funds no work could be advantageously carried on in the field. The office work has been restricted to the completion of records, rendition of reports, and preparation for possible future work.

A brief history of past work upon this improvement has been prepared by Assistant Engineer R. Ransom, and is herewith appended.

Recommendations for future work are as follows: That the present approved and adopted project be completed by thoroughly clearing the present channel of its remaining obstructions, at a total cost of $15,000 in addition to the $535.94 available 30th June, 1886; this amount to be appropriated in one sum within the next year. Smaller appropriations will increase the cost by about $2,000 per appropriation.

After this is done no further improvement is recommended at present; but the proper maintenance of the improved channel may cost from $1,000 to $2,000 per year.

This improvement, as regards cost and order of work, should be carried on approximately as follows:

Four thousand dollars to open a channel 100 feet wide and 8 feet deep through Foy's Flats by dredging and blasting.

Eight thousand dollars to cut off projecting points at sharp turns of the river.

Three thousand dollars to clear the entire river thoroughly of all remaining obstructions to its free navigation.

This river is in the collection district of Pamplico, N. C.

Money statement.

July 1, 1885, amount available		$670 44
April 23, 1886, amount received from sales to Contentnea Creek		25 00
		695 44
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$158 78	
July 1, 1886, outstanding liabilities	72	
		159 50
July 1, 1886, amount available		535 94
Amount appropriated by act approved August 5, 1886		3,500 00
Amount available for fiscal year ending June 30, 1887		4,035 94
Amount (estimated) required for completion of existing project		13,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		13,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

HISTORY OF THE IMPROVEMENT OF TRENT RIVER, NORTH CAROLINA.

The Trent River, from its mouth at New Berne, is navigable to Trenton, N. C., for 3-feet draught boats the year round.

1878. In December, 1878, a survey was made by J. M. Wolbrecht, under the orders of Capt. C. B. Phillips, Corps of Engineers, from Trenton to New Berne, and a map was made by Wolbrecht of that part of the river, and an estimate for $22,000 submitted to accomplish certain improvements having in view the clearing the river of snags, logs, stumps, overhanging growth, putting in temporary dikes, and dredging shoals. (See report of Wolbrecht, accompanying Report Chief of Engineers, 1881.)

1879 and 1880. In July, 1879, Congress made an appropriation of $7,000 for this improvement. The work of clearing the channel of logs, &c., and overhanging growth was begun in September, 1879, and on February 7, 1880, the first steamer reached Trenton. On February 9, 1880, work was suspended for want of funds. The principal work was done between Quaker Bridge and Trenton, a distance of 14 miles, and consisted in moving more than four times the number of obstructions which had been estimated for. The two cut-offs in this distance were widened and deepened, and boats could not pass them without such improvement. No diking was found necessary, and none has been constructed.

1880 and 1881. On June 14, 1880, $10,000 was appropriated by Congress for the continued improvement of this stream. The work of clearing out was resumed in August, 1880, at the mouth of the river and carried to Quaker Bridge, 29 miles, which point was reached in November following, when all work was suspended to February, 1881. A dredge-boat was hired in November, 1880, at Baltimore, but, owing to bad weather and other causes, did not get to work till February 10, 1881. Dredging was done at several points between Quaker Bridge and Trenton, mainly near Foscue's Landing, at cut-offs, Horse Lot or Ford, and within 1¼ miles of Trenton. About 25,000 cubic yards of material were moved, some of it shell rock, requiring blasting. The dredging cost about 25 cents to the cubic yard.

1881 and 1882. On March 3, 1881, $5,000 additional were appropriated by Congress for this work, and much of that amount was expended by June 30, following. Dredging was continued to August 18, 1881, and about 18,000 cubic yards of material moved, including 2,000 cubic yards shell rock, which had to be blasted. The channel was completed up to Trenton, and an unfinished turning basin was begun at Trenton. A small force on the banks was worked until August 31, 1881, when, for want of funds, all work was suspended.

1882 and 1883. Congress appropriated $10,000 more for this improvement August 2, 1882. The main work to be done was dredging, and it was found impracticable to hire a suitable dredge-boat; so nothing was done except by a small force, with improvised means, in removing 600 large and about twice the number of small trees from the banks, and taking 73 logs from the channel over the whole course of the stream below Trenton. This latter work was done in November and December, 1882, and January, 1883. Nothing was done from January, 1883, to June, 1883.

1883 and 1884. During August, September, October, and November of 1883 a small force was employed without regular machinery in removing obstructions from banks and channel. Of these 164 were large logs, 114 small ones, and 13 stumps were taken from the channel, and two small stone shoals were broken down by blasting, a little distance above Foscue's Landing. Late in December, 1883, a dredge was put to work and continued till end of March, 1884. The basin at Trenton was dredged to ample size for any boat that could reach Trenton. About 25,000 cubic yards of material were taken from the channel mainly from Trenton to a point 4 miles below, but one shell-rock shoal near Haus plantation was blasted and dredged, and several short bends were dredged off in the near vicinity. From December 1, 1883, to April 1, 1884, one of the steam hoisters from the Neuse was used in taking out obstructions. An accurate account of this work was not kept. A portion of it was removing 102 large logs and 67 stumps from channel and cutting off 278 large trees from banks and driving 44 large piles at Turning Basin, Trenton. The most of the dredged material had to be moved by hand and some required blasting.

1884 and 1885. July 4, 1884, an additional appropriation of $10,000 was made by Congress for the prosecution of this work, and from December, 1884, to April, 1885, the Turning Basin, at Trenton, was well and strongly revetted with wood and dug to 6 feet deep at low water, and the river from mouth to Trenton was cleared of snags, logs, &c., and overhanging growth; 565 logs and 52 stumps were taken from the channel. In February and March, 1885, careful surveys were made by Assistant Engineer J. P. Darling where dredging was supposed to be necessary, particularly near Trenton and at Foy's Flats, about 5 miles above New Berne. From April 3 to June 20, 1885, the river was dredged for 4,300 feet from Turning Basin, at Trenton, 4 feet deep and 75 feet wide to secure a 3-foot channel at low water, and 11,825 cubic yards of material were taken out. A log revetment extends along a great part of this 4,300 feet below Trenton.

The total amount appropriated for this work to date is $42,000. The work has been done by hired labor, and partially by hired machinery. The first dredging near Trenton filled afterwards on account of high water and the looseness of the sand and the very steep banks, and the basin, as at first revetted, was found to be so temporary as to require the subsequent work.

This work from beginning till 1885 was carried on to facilitate, as much as possible, the commerce over the river, and the smallness of the appropriations made it necessary to conduct it in apparently disconnected and irregular ways.

R. RANSOM,
Assistant Engineer.

MARCH 25, 1886.

L 3.

IMPROVEMENT OF THE NEUSE RIVER, NORTH CAROLINA.

Neuse River, emptying into the Pamplico Sound, has a total length of about 360 miles and a drainage area of 5,781 square miles (2,506 of which are situated above the mouth of its upper main tributary, the Contentnea). This river, when placed under governmental improvement in 1878, possessed during nine months of the year a 9-foot depth of channel from its mouth 40 miles up to New Berne, thence a 4-foot depth 50 miles further to Kinston, thence a 3-foot depth 46 miles further to Goldsboro', and thence a 2-foot depth 62 miles further to Smithfield, this channel depth being reduced during the low-water season to 8 feet at New Berne, 2 feet at Kinston, and 1 foot at Smithfield. Over the whole 198 miles the river was so blocked by war and other obstructions that navigation was impracticable. Its steamboat navigation was therefore nothing.

The original projects of 1871 for below Goldsboro', and of 1879 for above Goldsboro', contemplated for $174,000 in all, the removal of the war blockades and natural obstructions (only six thousand logs and snags) and the excavation of a few cut-offs, so as to get 4.5 feet at low water all the year to Goldsboro', and 3 feet during nine months to Smithfield. However, over sixteen thousand logs and snags had to be removed; and over 5,000 linear feet of log and brush jetties, and 43,000 linear feet of plank jetties, have had to be constructed to give only a portion of the originally projected improvement. The projects of 1878, 1880, and 1883, as continued to date, propose to remove all sunken logs, snags, floating and other obstructions, and to contract the channel-way by jetties so as to assure during the entire year an unobstructed 8-foot navigation 40 miles up to New Berne, and a similar 4-foot navigation 50 miles further to Kinston, and during nine months of the year a 3-foot navigation 108 miles further to Smithfield. The aggregate amount appropriated for these projects up to June 30, 1886, is $210,000. The present estimate (that of 1885), $370,000, for the final cost of the work, is based on these later developments.

Two hundred and five thousand eight hundred and twenty-five dollars and seventy-two cents have been spent in all upon this improvement up to June 30, 1886, giving a moderately well-cleared channel over the entire length of the river, allowing an 8-foot navigation 40 miles to New Berne, and a 3 foot navigation 50 miles further to Kinston all the year; also, a 3-foot navigation 46 miles further to Goldsboro', during nine months per year, and still 62 miles further to Smithfield six months per year. In consequence of this, two steamboat lines have been permanently established between New Berne and Kinston, and the river commerce has increased from almost nothing up to over $1,000,000 of goods transported per year, showing that each dollar spent on this improvement has been accompanied by the development of about $5 of annual commerce.

The navigation of this river is obstructed at points as shown by the following extract from special report dated January 17, 1885:

> Near Kinston this river is crossed by the Atlantic and North Carolina Railroad on a draw-bridge, whose draw-span is placed upon the shallow side of the river instead of over the main channel-way.
>
> The present improvement will probably be so far finished in 1886 as to permit of a deeper navigation above this bridge at Kinston than will then be able to pass through this draw-opening.
>
> All the steamer captains whom I have so far heard from state that they have not as yet been delayed from want of water at this draw-opening, and I do not see any reason for a change in the position of the draw before 1886.
>
> I therefore recommend that this draw may be permitted to remain in its present position for the present, but that it be moved to the channel side of the river as soon as it becomes the chief serious obstruction to a permanently increased depth of navigation between New Berne and Kinston.
>
> Near Goldsboro' this river is crossed by the Wilmington and Weldon Railroad, on a single-span bridge without a draw. The bottom of the bridge is about 17 feet above low water. The channel is said to be partially obstructed by a pier of the former bridge. Very few steamers have so far reached this bridge, although the river is navigable for several miles above Goldsboro'.
>
> I therefore recommend that this bridge be permitted for the present to remain in its present condition, provided that the owners will clear away the obstructing portion of the old pier beneath, and provided, also, that they will furnish a suitable hinge joint to the smoke-stacks of all steamers using regularly this portion of the river.
>
> Above Goldsboro' and below Smithfield there are six county bridges without draws, but there has as yet been no navigation demanding draws. When needed the draws will undoubtedly be put in by the county authorities. I therefore recommend that these bridges be permitted for the present to remain in their present condition, provided that their owners will insert draws therein whenever needed by the steamers.

The special work of the year is as follows:

Expenditures, $9,557.42.

Owing to its variable features, and the difficulty of properly specifying it beforehand and inspecting it afterwards, the work was allowably done by hired labor and the purchase of materials in open market.

Between the 6th of July and the 22d December, the river was systematically contracted by jetties over a total distance of about 2 miles, situated from 38 to 40 miles above New Berne, and from 10 to 12 miles below Kinston. This work could be done advantageously only at a mean stage of water. Work was much delayed by rain, freshets, and sickness. Two steam-hoisters were used on all available occasions.

Forty-one jetties (3,896 linear feet of jettying) were thus built in place; 1,125 linear feet of old undermined jetties, 65 logs, 102 large snags, and 3 cords of small snags, were removed from the river-bed; and 183 trees and 8 cords of brush were removed from 3,450 linear feet of the river bank. Maps were made of 2.5 miles of river preparatory to the location of the jetties; 63 guide-piles were driven, and 63 sign-posts were put up at the head and foot of 31 sets of jetties. All the old jetties were further strengthened by the addition of a sill on their up-stream sides at low-water level. A water-gauge was kept during the progress of the work. In June of 1886 the whole plant was overhauled, repaired, and put in order for the coming season's work.

The completion of a thoroughly cleared 4-foot channel from New Berne to Kinston will require further jettying over 1.5 miles of river, and the removal of a great many snags, logs, and trees from the bed of the river.

This work will be pushed forward rapidly during the coming high-water season, and carried as far as the present funds will permit.

All the above work has been well and vigorously carried forward under the immediate supervision of Assistant Engineer R. Ransom.

A brief history of past work upon this improvement has been prepared by Assistant Engineer R. Ransom, and is herewith appended.

Recommendations for future work are as follows: That this improvement be completed in accordance with the present approved and adopted projects, so as to secure a thoroughly cleared 9-foot navigation 40 miles up to New Berne, and a similar 4-foot navigation 50 miles further to Kinston during the entire year, and thence a similar 3-foot navigation 108 miles further to Smithfield during nine months of the year, at a total expense of $160,000 in addition to the $4,174.28 available 30th June, 1886, this amount to be appropriated in three yearly installments of about $60,000 each.

Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and the deterioration of plant will increase the cost of the work by from $2,000 to $6,000 per appropriation. Further improvements, so as to extend the navigation above Smithfield, or so as to increase the depth of water or length of time of such navigation below Smithfield, is not recommended at present.

After the improvement is finished its proper maintenance may cost from $2,000 to $6,000 per year.

This improvement, as regards cost and order of work, should be carried on approximately, as follows:

Thirty thousand dollars to secure an unobstructed channel of 3 feet depth at low water from New Berne, 50 miles upwards, to Kinston, by completing the present work of contraction of the river channel.

Thirty thousand dollars to secure a thoroughly cleared natural channel from Kinston, 108 miles upward, to Smithfield, by removing all sunken logs and snags, and by cutting down and pulling back from caving banks the trees which would otherwise soon fall into the river.

Twenty thousand dollars to increase the channel depth from New Berne to Kinston to 4 feet at low water by dredging and jettying.

Eighty thousand dollars to increase the channel depth from Kinston to Smithfield to 3 feet during nine months of the year by dredging and jettying.

This river is in collection district of Pamplico, N. C.

Money statement.

July 1, 1885, amount available		$13,731 70
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$9,166 05	
July 1, 1886, outstanding liabilities	391 37	
		9,557 42
July 1, 1886, amount available		4,174 28
Amount appropriated by act approved August 5, 1886		22,500 00
Amount available for fiscal year ending June 30, 1887		26,674 28
Amount (estimated) required for completion of existing project		142,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		60,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

HISTORY OF THE IMPROVEMENT OF NEUSE RIVER, NORTH CAROLINA.

Under the direction of Major Craighill, Corps of Engineers, a survey of the river was made from New Berne to Goldsboro' in May and June, 1871, by Mr. William Popp, and in November, 1878, an examination of the stream from Goldsboro' to Smithfield was made under direction of Captain Phillips, Corps of Engineers, by Mr J. M. Wolbrecht.

1878 and 1879. By act Congress, June 18, 1878, $40,000 was appropriated for the improvement of the stream. The project adopted contemplated clearing the stream of obstructions from mouth to Goldsboro', and making certain cut-offs, but it was determined to expend the $40,000 in removing obstructions. Preparations were made in September and work began October 1, 1878, at Fort Point 3 miles below New Berne, taking out artificial obstructions of a blockade placed there during the war between the States. Only a very narrow channel was then open; one, 550 feet wide, was cleared, taking from it four, and at Johnson's Point, a mile below, two vessels, a lot of piles, and two lines of "Yankee catchers." Blasting was required. A channel east of the city of New Berne, and close to it, was dredged 450 feet way, 100 feet wide and 8 feet deep, saving nearly a mile in going from one river to the other, in the year of 1878. At upper blockade, 3 miles above New Berne, the channel was widened to 150 feet through Linkfield Channel by removing five vessels and some piles. The work progressed to 15 miles above Kinston by June 30, 1879. The work from Linkfield Channel up was confined to removing snags, stumps, and overhanging growth, and in putting in some approaches to the draws of bridges. The clearing out of obstructions was partial, as it was very desirable to open the way as far up as possible for the passage of boats. On the 3d of March, 1879, $45,000 additional was appropriated by Congress to continue the improvement. By the end of June, 1879, five experimental lumber jetties were built just below Kinston.

1879 and 1880. Work of clearing out continued to Goldsborough, which point was reached in February, 1880, and the force was taken in March to below New Berne, and the whole blockade, where the river is a mile wide, was removed, consisting of 13 vessels, several barges, 100 piles, and two lines "Yankee catchers," entirely across stream, 5 vessels, 2 barges, and several cribs taken from the blockade 3 miles above New Berne. A sunken transport was taken out just above Red Old Field. Clearing out snags, &c., progressed to 3 miles above Pitch Kettle by June 30, 1880. The blockade 5 miles below Kinston was partially removed, and an 80-foot channel opened through it. Nine lumber jetties were put in between Kinston and County Bridge below, experimentally to determine proper distance between them for future construction. Ten rough "bank protectors" of double rows of piles filled with brush and logs were built below railroad bridge near Kinston. Two steam hoisting machines were built in summer of 1879.

1880 and 1881. On June 14, 1880, Congress appropriated $45,000, and March 3, 1881, $30,000 more to continue this improvement, and allowably by law these amounts could be used to improve the river above Goldsboro'. The work of clearing the bed of streams and the banks was carried to 12 miles above Goldsboro' from January to July 1, 1881. Below Kinston the same work was carried from near Pitch Kettle to Kinston. Two pile-drivers were put on the hoisters. About 5,000 linear feet of log and brush jetties were put in between Pitch Kettle and Deer Neck, and 600 linear feet of brush and log dams built near Grindle Creek. The troublesome points at Southwest Bends and Bull Point were revetted with piles and logs for nearly a mile, and at other places on the river bank protectors to prevent erosion were built. The brush and log jetties did not stand satisfactorily, and in May and June, 1881, 3,230 linear feet of lumber jetties were built below and near Kinston.

1881 and 1882. By act of Congress March 3, 1881, $30,000 was appropriated to continue this improvement, and work of clearing out above Goldsboro' progressed 20 miles during this season. In June, 1882, 220 large and 231 small logs, 11 large and 25 small stumps were taken from bed of stream, and 897 large and 909 small trees cut from banks. This is a fair sample of what had previously been done. On the lower Neuse the channel east of the city, which was previously dredged in 1878, was extended and deepened to 660 feet way, 100 feet wide, and 9 feet deep; 14,550 linear feet of lumber jetties were put in between Pitch Kettle and Becton's Old Field. But little injury from any cause to lumber jetties this season.

1882 and 1883. Act of Congress August 2, 1882, appropriated $35,000, $5,000 of which was to go to inland line of navigation, New Berne to Beaufort, and $30,000 to Neuse River proper. Clearing out continued to Smithfield, which place was reached May 15, 1883. During the year 2,331 large and 1,891 small logs and trees, and 341 stumps were taken from bed of stream, and 4,968 large and 8,743 small trees cut from banks. Up to November, 1882, one hoister had been hired; it was then discharged. Three thousand eight hundred and twelve linear feet of lumber jetties were built between Kinston and Becton's Old Field. During the winter one steam hoister took out logs, &c., from "Let Alones" above Kinston. Lumber jetties stood well.

1883 and 1884. In July work was gone over from Goldsboro' to Kinston by one hoister, taking out over that distance 174 large and 31 small logs and 41 stumps. Jettying was begun August 1, 1883, and continued to October 22, 1883; resumed June 1, 1884. Put in during year ending June 30, 1884, 4,450 linear feet in vicinity of blockade, 5 miles below Kinston. During year injury to eight jetties; to two serious. In November, 1883, the steam hoisters were repaired.

1884 and 1885. Act of Congress of July 5, 1884, appropriated $20,000 for continuation of this improvement. Between 1st July and middle December, 1884, 121 lumber jetties, aggregating 12,402 linear feet, over a distance of 5 miles between blockade below Kinston and Becton's Old Field, were built; 164 logs and 50 stumps and several cords small stuff were taken from the stream. Maps of 10 miles of river over part jettied were made. Two new quarter-boats and four new flats were built; and a steam pump, mainly for use in sinking piles by water-jet, was put on one of the hoisters.

1885 and 1886. Work began July 11, and continued to December 22, 1885. Beginning about a mile above Becton's Old Field, and continuing to include Deer Neck, there were built 4,509 linear feet of lumber jetties, 1,125 feet of old jetties removed, 183 trees and 75 cords of brush cut, 3,450 feet of banks cleared, 102 large snags and 3½ cords small stuff taken from bed of stream, 63 guide-piles and 63 guide-posts put up, and the river sounded from starting point of season to vicinity of Maple Cypress.

All work on the river has been done by hired labor and some hired machinery. Material bought in open market till 1885; since then by sealed bids.

The original project contemplated the removal of natural and artificial obstructions from mouth to Goldsboro' and making some cut-offs. The idea of cut-offs was afterward abandoned. Then it was decided to get a 3-foot channel year round to Kinston, the same to Goldsboro' for nine months, and Smithfield for six months in year. Subsequently it was found expedient to secure a 4-foot channel to Kinston; and work is to continue with that end in view, and to keep open the channel from year to year, as necessity may require. Several bridges exist below Goldsboro' all of which have draws. Including the railroad bridge near Goldsboro' from there to Smithfield, there are seven bridges without draws. The draw in railroad bridge near Kinston is on wrong side river, and may require change. No demand for draws seems *now* to exist where they are not.

It is proper to explain the irregularity apparent in the method of building the jetties. The chief object in view at the beginning of the work was to afford all possible facility for transportation, and the worst parts of the river received most prompt attention. Changes from point to point were made as the necessity of the steamers seemed to demand. For the past eighteen months or two years the work has progressed more regularly as these passing demands did not occur.

High water causes a suspension of operations for the present.

L 4.

IMPROVEMENT OF THE LINE OF INLAND NAVIGATION FROM NEW BERNE TO BEAUFORT HARBOR, NORTH CAROLINA, VIA CLUBFOOT, HARLOWE, AND NEWPORT RIVERS.

The inland line of navigation from New Berne to Beaufort Harbor, via Clubfoot, Harlowe, and Newport rivers was established in about 1826, and was used thereafter by small craft until about 1856, when its locks broke down and the route was abandoned.

This line, about 42 miles in total length, extends from New Berne about 23 miles down the Neuse River, 6 miles up Clubfoot River, 3.21 miles through the Clubfoot and Harlowe Canal, 3.5 miles down Harlowe River, and 6 miles through Newport River to Beaufort Harbor.

Since 1880 the line has been reopened by the New Berne and Beaufort Canal Company so as to allow in 1885 the passage of small boats of 15 feet width and 3 feet draught. This inland line of navigation, via Clubfoot, Harlowe, and Newport rivers was recommended in 1883 as worthy of improvement, providing that Congress desired to extend the already existing lines of navigation from the Chesapeake southward; and the cost of a channel 80 feet wide and 9 feet deep, was estimated at $883,580, increased by the cost of a tide-lock and the canal company's franchise.

Ten thousand dollars were appropriated in 1882 ($5,000 to be taken from the appropriation for Neuse River, $5,000 from that for Beaufort Harbor) for an inland line of navigation from New Berne to Beaufort Harbor, and it was decided in 1884 that this money was to be spent upon the route via Clubfoot, Harlowe, and Newport rivers.

The adopted project of 1884 for the expenditure of this $10,000 as continued to date, proposed to widen and deepen Harlowe Creek so as secure a through canal of 5 feet depth at mean low water and of 30 feet bottom width from the mouth of Harlowe Creek upward 3.25 miles to its head, and to use the remaining funds upon similar works on Clubfoot River. It was required that the work should be done at once and by contract. Work was commenced in 1884, but on account of unexpected obstacles and the small amount of available funds the contractor could not afford to build or hire the expensive plant that he would need in order to be able to fulfill his contract, and had to abandon the work. Owing to these developments, and the great disproportion between the available funds and the estimates of 1883, further work was stopped in March, 1885, to await the further action of Congress. The aggregate amounts appropriated for these projects up to June 30, 1886, is $10,000. The present estimate (that of 1885), $92,000 for the final cost of the work, is for a channel 30 feet wide and 5 feet deep, adapted to the existing navigation of the Neuse River desiring passage by this route to Beaufort Harbor.

Up to June 30, 1886, $2,205.76 has been expended in all upon this improvement, on necessary surveys, in superintendence, and in the above-described commencement of the proposed cutting.

A small light-draught steamer has just commenced running over the line, but it has not yet had time to work up a permanent business.

The special work of the year is as follows:

Expenditures, $131.45.

No field work has been done since March, 1885, for the reason above given. The canal was inspected in April; and in June, 1886, authority was given to expend about $800 in removing logs and snags from the bed of Harlowe Creek, and this work will be commenced in July, 1886.

A history of past work upon this improvement has been prepared by Assistant Engineer R. Ransom, and is herewith appended.

Recommendations for future work are as follows: That this improvement be extended in general accord with the projects of 1883 and 1884 over the whole distance, through the New Berne and Beaufort Canal, as well as through Clubfoot River and Harlowe Creek, so far as to secure a through channel of 5 feet depth at mean low water and 30 feet bottom width from the mouth of Harlowe Creek to the mouth of Clubfoot River, thus completing a 5-foot navigation from New Berne to

Beaufort, at a total expense of $85,000, in addition to the $7,794.24 available June 30, 1886; this amount to be appropriated in two yearly instalments of $50,000 and $35,000, respectively. Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and the deterioration of plant, will increase the cost of the work by from $1,500 to $4,000 per appropriation.

If no funds are appropriated for the fiscal year ending 30th June, 1887, the $7,794.24 on hand should be used by hired labor and open purchase of material to give as good a channel as possible to the craft now using this route. If well opened this line would be of much value as a connecting link between Pamplico Sound and Beaufort Harbor, and would complete an otherwise already existing inland navigation from the Chesapeake to Beaufort, N. C.

The dangers of ocean travel around Cape Hatteras and Cape Lookout are so great that some such 5-foot navigation for small vessels appears necessary between Pamplico Sound and Beaufort Harbor, and no similar navigation can be secured by any other route, except at greatly increased expense. Further improvement over this route, so as to secure a channel of more than 5 feet depth at low water is not recommended for the present.

After this improvement is completed its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement as regards cost and order of work should be carried on approximately as follows:

Thirty-five thousand dollars to secure a channel 30 feet bottom width and 5 feet deep at low water from the head of Harlowe Creek 3.25 miles downward to a 5-foot depth at low water in Newport River by dredging.

Fifteen thousand dollars to secure a similar channel from the head of Clubfoot Creek to the Neuse River by dredging.

Forty thousand dollars to repay the New Berne and Beaufort Canal Company its past expenses of dredging in the canal, and to secure a channel of 30 feet bottom width and 5 feet depth through the canal by dredging.

This work is in the collection districts of Beaufort and Pamplico, N. C.

Money statement.

July 1, 1885, amount available		$7,925 69
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1 97	
July 1, 1886, outstanding liabilities	129 48	
		131 45
July 1, 1886, amount available		7,794 24
Amount appropriated by act approved August 5, 1886		10,000 00
Amount available for fiscal year ending June 30, 1887		17,794 24
Amount (estimated) required for completion of existing project		77,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

HISTORY OF THE IMPROVEMENT OF INLAND LINE OF NAVIGATION, NEW BERNE TO BEAUFORT.

About sixty years ago the State of North Carolina cut a small canal from the head of Clubfoot Creek to the head of Harlowe Creek, thereby connecting Neuse and Newport rivers. For thirty years the canal was used for small craft, but for the past thirty years has hardly been used at all.

In the winter of 1878-9 a survey, in connection with a contemplated line of inland navigation from Norfolk, Va., to Wilmington, N. C., was made over this route by the Engineer Department under the direction of late Capt. C. B. Phillips, Corps of Engineers.

On 2d August, 1882, an allotment of $5,000 each was made from the appropriations for Neuse River and Beaufort Harbor to improve the water-way between New Berne and Beaufort, but some indefiniteness in the law delayed beginning work upon any line.

In the fall of 1883, under the direction of Captain Mercur, Corps of Engineers, J. P. Darling, assistant engineer, made a survey of Clubfoot and Harlowe creeks and part of Newport River, and submitted an estimate for the work.

During 1884 it was determined to expend the $10,000 above mentioned, upon Harlowe Creek over the line surveyed by Darling, and a project was adopted which was to secure a channel 30 feet wide at bottom and 5 feet deep at mean low water over the course of the creek from head to mouth. The work was let by contract to T. P. Morgan. The specifications required a clear berm of 12 feet from edge of cut, that all material dredged should be deposited on one side, and that the material should at no point be over 4 feet high.

In October, 1884, the line was staked, and on the 29th that month the first dredge, a simple and small dipper-pattern one, was at the point where the work was to begin. This machine failed, after repeated trials, to comply with requirements of contract. On 19th December, 1884, a grapple-dredge came, but failed likewise to fill the contract. Besides, caving on account of the nature of the marsh occurred, and experiments of two kinds were made to floor the marsh, but with results hardly satisfactory.

The contractor suspended operations after taking out less than 2,000 cubic yards, and by the 12th of March, 1885, had withdrawn his machinery.

The Engineer Department recommended an annulment of the contract without future prejudice to the contractor.

It is now recommended by Capt. W. H. Bixby, in general charge, to extend the present adopted project through the New Berne and Beaufort Canal as well as through Clubfoot and Harlowe creeks, so as to secure a 5-foot depth at mean low water and a 30-foot bottom width from mouth of Harlowe Creek to mouth of Clubfoot Creek, at a total expense of $90,000.

All operations are suspended to await the action of Congress upon the above recommendation.

The old canal connecting Clubfoot and Harlowe creeks a few years ago fell into the hands of a private corporation, and they have dug it out over nearly the entire length to a depth of 3 feet at mean low water and a width at bottom of about 30 feet.

During the season of 1884-'85 a resurvey was made by order of Capt. W. H. Bixby, Corps of Engineers, of Harlowe Creek from its head to its mouth by R. B. Burks, surveyor, under supervision of R. Ransom, assistant engineer. Bench-marks were established; high and low water lines and line of soft and hard marsh marked; soundings of water taken over the whole course, as well as soundings of mud on each side of the stream, records of which survey are in the central office at Wilmington, N. C.

R. RANSOM,
Assistant Engineer.

MARCH 27, 1886.

L 5.

IMPROVEMENT OF BEAUFORT HARBOR, NORTH CAROLINA.

Beaufort Harbor, at the eastern terminus of the Atlantic and North Carolina Railroad, is the only harbor of any importance between Chesapeake Bay and Wilmington, N. C., a distance of over 300 miles. It is especially valuable as the natural outlet to the inland commerce of northern and middle North Carolina and as a natural harbor of refuge to vessels overtaken on this most exposed portion of the Atlantic coast. If its channel were marked by range lights it would be the easiest harbor to enter between the Chesapeake and Savannah. Beaufort Harbor when placed under governmental improvement in 1880 possessed a bar entrance of 15.3 feet least depth at mean low water, with an average rise and fall of tide of 3 feet. At this time, however, the harbor entrance was rapidly deteriorating, its width, measured from Fort Macon Point to Shackelford Point, having increased 500 feet between the years 1864 and 1880 and increased 900 feet more between the years 1880 and 1881, and its bar having rapidly and proportionally shoaled. From the bar, the harbor possessed a channel of 25 feet depth upwards 3.7 miles to the Atlantic and North Carolina Railroad Wharf at Morehead City; and a branch channel of 9 feet depth for 0.6 mile up Bulkhead Channel, and of 2 feet minimum depth 0.6 mile further to the wharves of Beaufort City, where coasting vessels had a good wharfage of 7 feet depth and 1,800 feet length.

The original project of 1881 proposed for $82,000 to stop the erosion at Shackelford Point by three 200-foot jetties (to cost $30 per linear foot) and to extend the 9-foot depth of water from Bulkhead Channel to Beaufort City, by a cutting 200 feet wide, and thence to dredge a 6-foot channel 100 feet wide to North River and Core Sound for the accommodation of the small craft of the neighboring sound. The violence of the sea's action proved so great that the 600 feet of jetty actually cost fully $36,000 ($60 per linear foot) and is not even yet sufficiently strong.

Moreover, 400 feet more of jetty became necessary, and similar work became necessary on the other side of the entrance, at Fort Macon Point.

The projects of 1881, 1882, and 1884, as continued to date, proposed to secure this harbor by stopping further erosions of the sand-banks at Shackelford Point and Fort Macon Point, and thus stopping further deterioration of the bar entrance; and propose to open a 5-foot channel 100 feet wide to Beaufort City. The aggregated amount appropriated for these projects up to 30th June, 1886, is $75,000. The present estimate (that of 1885), $159,000 for the final cost of the work, is based upon the experience of the past years.

Seventy-five thousand dollars have been spent in all upon this improvement up to June 30, 1886, in successfully stopping the erosion of Shackelford Point and Fort Macon Point, in probably arresting the shoaling upon this bar, and in making a careful survey of the present condition of the harbor entrance preparatory to the definite location of further works. No improvement of commerce nor depth of water was thereby expected or obtained, but the retrograde movement has been in general arrested, and the old shore lines have commenced to re-form as desired. The commerce is now about $1,000,000 exported or imported.

The special work of the year was as follows:

Expenditures, $2,218.56.

Owing to its variable features, and the difficulty of properly specifying it beforehand and inspecting it afterwards, the work was allowably done by hired labor and the purchase of materials in open market.

Work was stopped on the 8th September to await further appropriations; but a few necessary repairs were made later on.

At Shackelford Point, the severe storms of August and October, 1885, washed the stone riprapping away from the top of the main jetty (now 535 feet long), so as to undermine its coping over one-third of its width and 240 feet of its length. The sea-front of the jetty and its coping was temporarily protected in December and January by 220 linear feet of crib-work revetment made of logs tied back to the coping by iron rods.

The jetty, however, needs as soon as possible to have this crib-work replaced by heavy stone weighing over 1,000 pounds to the piece.

The middle jetty, built to 100 feet length in 1882, at a point 1,000 feet east of the main jetty, has almost disappeared by being gradually washed away by the North River and Core Sound currents. It needs to be reconstructed more permanently.

The east jetty, built to 400 feet length in 1885, at a point 2,300 feet east of the main jetty, has been raised by the addition of 165 cubic yards of stone (3,246 in all since commencement). It has, as desired, effectually checked further erosion of the north side of Shackelford Point, and has commenced the restoration of the eroded point. It needs to be raised to above low-water level throughout its length. The bank on the east side of this jetty has been successfully protected from erosion by a cheap brush and stone revetment of 15 feet width and 100 feet length.

As a result of these jetties, Shackelford Point, during the past year, has, as desired, advanced towards its former shore-lines, reclaiming from the ocean a strip of beach 200 feet wide and over 1,000 feet of length.

At Fort Macon Point.—The small landing wharf was completed. The main jetty was extended backwards 115 feet so as to be well connected to the sand-hills in its rear. It is now 410 feet long. This extension was crowned, like the rest of the jetty, with concrete blocks, each 20 feet long, 6 feet wide, and 3 feet thick, built in place.

The northwest jetty, built opposite the old railroad wharf, to protect the northern shore of Fort Macon Point from erosion by the Newport River current, was extended 162 feet (202 in all since commencement), and loaded with 141 cubic yards (200 in all) of stone. It needs to be raised above low-water level throughout its length. Though unfinished, its good effect is already perceptible.

The harbor survey was completed.

All the above work has been vigorously carried forward under the immediate supervision of Assistant Engineer R. Ransom.

A brief history of past work upon this improvement has been prepared by Assistant Engineer R. Ransom and is herewith appended.

Recommendations for future work are as follows: That the present approved projects be completed, so far as to thoroughly protect Shackelford and Fort Macon from further erosion ($80,000) and to dredge a reduced channel of 100 feet width and 5 feet depth, at low water, from Bulkhead Channel entirely through to Beaufort City ($4,000), at a total expense of $84,000, in addition to the funds available on the 30th June, 1886; this amount to be appropriated in one sum during the next year.

Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, deterioration of unfinished work, extra superintendence, and deterioration of plant, will increase the cost of the work by from $3,000 to $5,000 per appropriation.

Further improvement in accord with the original project, so as to secure the Beaufort City a channel of over 5 feet depth at low water from Bulkhead Channel, or of any depth of water by any other route to North River and Core Sound, is not recommended. This improvement once thoroughly completed should be permanent. The harbor entrance should be provided with a pair of range lights visible to a distance of 6 miles. It would then be of great value as a harbor of refuge. The least depth of water in its bar could probably be easily increased to 18 feet at low water, as it is said to have been in 1737 and 1830; $300,000 would probably cover the entire cost of this increase of depth.

This improvement, as regards cost and order of work, should be carried on approximately as follows:

Seven thousand dollars to thoroughly riprap with heavy stone (1,000-pound pieces) the sea front of the main jetty at Shackelford Point.

Eight thousand dollars to raise to high-tide level the railroad wharf jetty at Fort Macon Point.

Four thousand dollars to secure a channel 100 feet wide and 5 feet deep at low water from Bulkhead Channel through to Beaufort City by dredging.

Two thousand dollars to re-establish line of sand-dunes along the new shore-line by means of catch sand fences at Fort Macon Point and Shackelford Point.

Seven thousand dollars to raise to high-tide level the eastern jetty at Shackelford Point.

Eight thousand dollars to reconstruct with heavy stone the middle jetty at Shackelford Point.

Eight thousand dollars to crown with concrete capping the southern jetties at Fort Macon.

Forty thousand dollars to construct 900 linear feet more of jetties at Shackelford Point at points south of the main jetty.

Beaufort is a port of entry.

Money statement.

July 1, 1885, amount available	$2,218 56
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,218 56
Amount appropriated by act approved August 5, 1886	15,000 00
Amount (estimated) required for completion of existing project	74,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	74,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

HISTORY OF THE IMPROVEMENT OF BEAUFORT HARBOR, NORTH CAROLINA.

A survey of the harbor was made by the Engineer Department in 1821, another by the Navy in 1839, and others by the Coast Survey in 1857, 1862, 1864, and 1876, and by Captain Phillips, Corps of Engineers, in 1880.

Some thirty years ago or more five spur-jetties of large stone were built on the east and south of Fort Macon at that point. One has entirely disappeared, another much sunken, and those to the eastward have been added to since 1881.

1881 and 1882. The river and harbor act, March 3, 1881, appropriated $30,000 for this improvement.

The project adopted contemplated placing spur-jetties around Shackelford Point and dredging channels to improve approaches to town of Beaufort, but was so modified as to use the whole appropriation in jettying. Work was begun 1st of April, 1881, two scows built, wharf put up, tramway started, and the head of a jetty built, and 30 feet of the foundation laid at Shackelford Point. The line of jetty is from point directly towards the flag-staff at Fort Macon. The foundation of all the jetties newly built are of log-mats, firmly fastened, from 30 to 40 feet long, lying cross the line of jetty. Nothing was done in 1881, 1882, 1883. The river and harbor act August 2, 1882, appropriated other $30,000 for this work, but $5,000 of it was to improve inland line navigation, New Berne to Beaufort. Five hundred and thirty-five linear feet of jetty, in line indicated for 1881–1882, 30 feet wide at bottom and raised to mean low-water level, was built. Sand accumulated to top of work for 300 feet of its length. One thousand feet east of above-named jetty, up Core Sound, a small jetty 100 feet long, 15 feet wide at base, 5 feet at top, and 1 foot above mean high water, was built. One thousand feet tramway (400 of it trestle), a wharf repaired, 2,800 feet of brush sand-catch, from 4 to 5 feet high, were also built, and two other scows constructed. In December, 1882, work was begun at Fort Macon under an appropriation for defences. The three old jetties, Nos. 1, 2, and 3, beginning from the east, were lengthened, broadened, and raised. At that time No. 1 was 145 feet long, No. 2 185 feet long, and No. 3 190 feet long. The sea had cut behind Nos. 1 and 2, and water 4 feet at low tide ran between the ends and the land. Nos. 1 and 2 were connected with the land by laying mats 35 feet wide and raising the whole jetty to 1 foot above mean high water, with top 6 feet wide. No. 3 was raised and widened as the other two, except that it was raised to 2.5 feet above mean high water, and its out end was broadened by an apron to 30 feet wide. No. 1 was then 295; No. 2, 360; and No. 3, 225 feet long respectively. A tramway 2,020 feet long and a wharf were built. A spur at right angles to No. 1, about its middle, was run 150 feet perpendicularly to the north, 15 feet at base and 4 or 5 on top, was put in to above mean low-water line, and 5,962 feet of sand-catch fences were built.

1883 and 1884. At Shackelford Point the main jetty, 535 feet long, was raised 1 foot above low water, and later 250 cubic yards placed upon it. It was determined to cap this structure with concrete in blocks 20 feet by 6 feet by 3 feet, 2 inches apart lengthwise, and material was received to begin the work.

At Fort Macon Point, under a defense appropriation, a jetty 150 feet long and 30 feet at base was built 350 feet inside of Jetty No. 1 and raised 1 foot above mean high water. A second one was started about same distance still farther inside, but stopped for want of funds. The spur to No. 1 was raised 1 foot.

From October 1883, to April, 1884, operations were suspended. Storms in September, 1883, and January, 1884, destroyed sand-fences and made a break behind Jetty No. 1, which was stopped with lumber dams. Operations were resumed in April, 1884. Sand-fences were partly restored, 150 cubic yards of rubble-stone added to Jetties Nos. 1 and 2, and 300 cubic yards leveling up 540 linear feet of these jetties to receive concrete capping. About 280 feet, linear, were so placed on Jetty No. 1 in blocks 20 by 6 by 3 feet, except at out end, where they were 5 blocks of 3 by 6 by 3 feet.

1884 and 1885. By act of Congress July 5, 1884, $20,000 were appropriated to continue this work.

At Shackleford Point 444 linear feet of main jetty was capped with concrete in blocks 20 by 6 by 3 feet, the jetty being first brought to a level above mean low water. The outer end was undermined to a slight extent, and stone, together with about 100 sacks of cement, were added.

Two thousand three hundred feet east of this main jetty a new one 400 feet long, in irregular line, 30 feet broad for 200 feet and 40 feet broad for the outer 200 feet, was built, not to surface of water. Seven hundred and twenty-one feet of brush and stone revetment were laid between the two jetties. The small jetty built in 1882 had about disappeared.

A revised project for Fort Macon Point included works then in the harbor improvements. Four hundred and twenty feet, linear, of cuts through sand-hills were closed by a crib-work filled with sand 9 feet high by 12 feet wide, most strongly built west of the fort. This crib-work is now half covered by sand-dunes, and the shore-line in front has risen above the level of the highest storm-tides. A small wharf was started, and a new jetty northwest of the fort and about 125 feet from the old railroad, was begun and 40 feet of its foundation laid, and under Captain Bixby's orders H. F. Price, assistant engineer, commenced a survey of the harbor in June, 1885.

1885 and 1886. The west end of Jetty No. 1, at Fort Macon Point, was extended 120 feet and capped with concrete, as the other part, in July and August, 1885. The small wharf was completed in July, 1885, and about 200 feet of the foundation of new jetty west of wharf was put down in July, August, and September, 1885.

At Shackelford Point 157 cubic yards of stone were put on new jetty in Core Sound, and it is now, for over 175 feet, about on level with low water next the shore end and about 9 feet under water at extreme out end. One hundred feet, linear, brush and stone revetment, 15 feet wide, were laid between the jetties and near the new one.

Eleven of the concrete blocks on the main jetty at this point had to be supported by strong frame-works of logs and iron rods next the outer end, the third one from the end being entirely undermined and fallen its entire length. The action of the undermining seems not to have stopped, though no other blocks have fallen.

All the foregoing work was done by hired labor.

R. RANSOM,
Assistant Engineer.

MARCH 26, 1886.

COMMERCIAL STATISTICS OF BEAUFORT, NORTH CAROLINA.

[Vessels, coasting, 140.]

EXPORTS.

Articles.	Quantity.	Value.
Clams ... barrels	2,000	$2,000 00
Escallops ... bushels	2,000	800 00
Oysters ... do	40,000	10,000 00
Fresh fish ... packages	2,600	10,400 00
Fresh fish ... pounds	500	12 50
Salt fish ... do	6,000	150 00
Fish-scrap ... tons	1,200	800 00
Fish-oil ... gallons	20,000	4,400 00
Cotton ... bales	1,500	67,500 00
Rice ... bushels	15,000	19,500 00
Irish potatoes ... barrels	1,200	2,400 00
Sweet potatoes ... bushels	200,000	100,000 00
Naval stores ... barrels	1,000	800 00
Watermelons ... number	100,000	8,000 00
General merchandise ... tons	15,136	45,408 00
Total	...	271,670 50

IMPORTS.

Articles.	Quantity.	V
General merchandise, guano, ice, coal, corn, &c	...	$750,000 00
Total value exports and imports	...	1,021,670 50

REMARKS.

The number of foreign vessels either entering or departing and of home vessels registered is not stated.

L 6.

IMPROVEMENT OF NEW RIVER, NORTH CAROLINA.

New River, emptying directly into the Atlantic Ocean between Beaufort Harbor and Wilmington, N. C., has a total length of about 52 miles, and a drainage area of 492 square miles. Its lower 14 miles, from its mouth to Jacksonville, forms a fine basin of brackish water of from 500 to 10,000 feet width and of at least 5 feet channel depth, with 40,000 acres of oyster farms, and with rich agricultural surroundings. When placed under Government improvement in 1882 it had very poor facilities for transporting its goods to market. Its communication with the ocean was blocked by an oyster-rock barricade, through which there existed only a long and very crooked channel of 50 feet width and 3 feet depth at low water. Its commerce, limited to wagons and small boats, was estimated to be about $400,000 of goods per year.

The original project of 1882 proposed for $40,000 to secure a 150-foot channel 5 feet deep at low water from the upper river to the ocean, by dredging the old channel to its full size through about 7,000 feet of this oyster-rock barricade. Ten thousand dollars was appropriated, but no money was spent upon this improvement up to 30th June, 1885, because the available funds were regarded as too small to allow of their being spent profitably.

The location and the surroundings of the proposed work were personally inspected in June 1885. This inspection revealed the fact that the improvement was much needed, and that a differently located channel might be better for permanent improvement, and that the available funds might be sufficient to cut this channel wide and deep enough for immediate use.

The aggregate amount appropriated for this project up to 30th June, 1886, is $10,000. The present estimate (that of 1885), $40,000, for the final cost of the work, is the same as that of 1882, except that it is based upon a new location of the channel.

Nine thousand eight hundred and ten dollars and twenty-four cents has been spent in all upon this improvement up to the 30th June, 1886, replacing the long and crooked channel by a short and straight channel of 40 feet bottom width and 3.5 feet depth at low water. This new channel gives great satisfaction to the neighborhood, is already in daily use by the craft entering New River from the ocean, and is steadily deepening under the scour of the river and tidal currents. The improvement is too recent to show as yet any marked increase in the commerce of the river.

The river navigation is not obstructed by any bridges below its present head at Jacksonville.

The special work of the year was as follows:

Expenditures, $9,810.24.

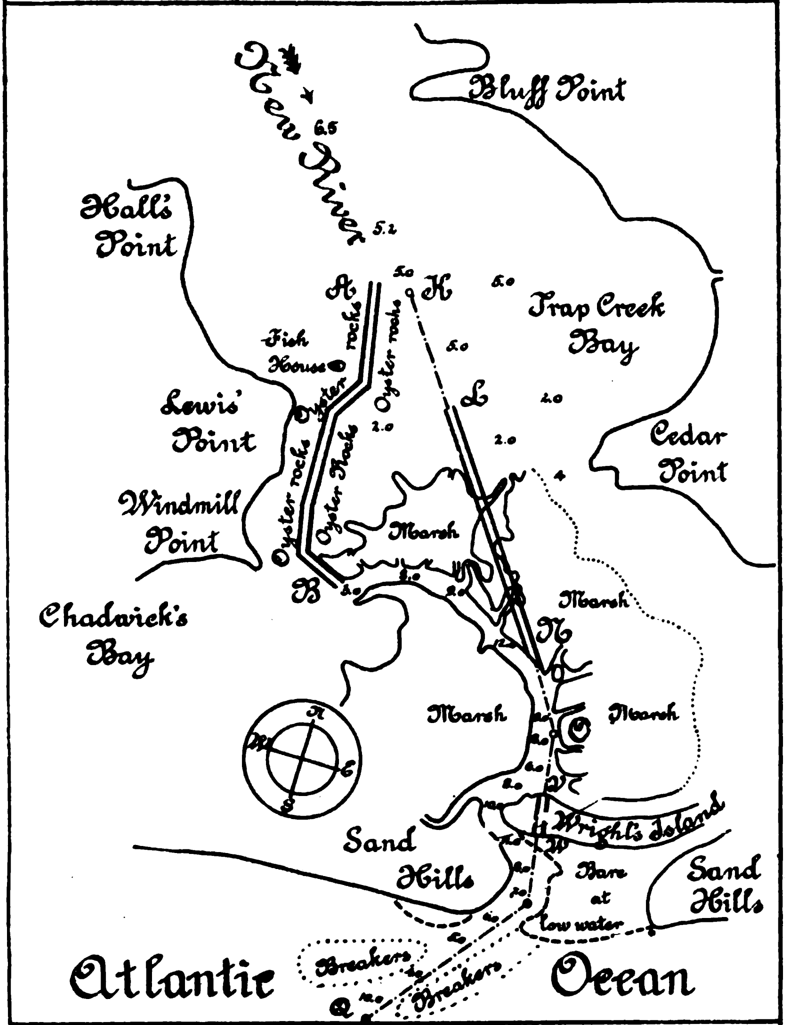
The amount of funds available for this improvement was so small, the difficulty of getting to the place of work so great, and the nature of the work so troublesome, that no available bid could be expected from responsible contractors in case the work was advertised and bids solicited in due form. Work was, therefore, allowably done by hired labor and the purchase of materials in open market.

All work in the field was postponed until cold weather rendered the locality safe as regards health. In July a brief survey was made, and a new project suggested. In November and December, 1885, a full survey was made, the line of cutting staked out, the right of way obtained, and the new project approved.

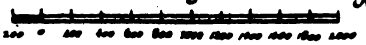
In January an agreement was entered into with Mr. Rittenhouse Moore, of Mobile, for the removal of about 32,000 cubic yards of the material along a line through the marsh at Cedar Bush Cove, for 25 cents per cubic yard, measured *in situ*, this material to be deposited over 30 feet away from the cutting and to be removed in such way as to give a final through cut of about 40 feet bottom width and about 4 feet depth at low water. This special agreement was made because it was known that Mr. Moore had at leisure a dredge just exactly suited to the work and a foreman who was familiar with the locality and who could be depended on to do thoroughly the desired work. Between the 1st of March and the 27th of May this dredge removed 32,284 cubic yards of sand, shells, and mud, opening a straight channel 5,800 feet long, 40 feet wide at bottom, 4 feet deep over the greater portion of its length, and 3.1 feet deep at its lower end. This least depth, as expected, is steadily increasing under the scour of the river and tidal currents, and had reached 3.5 feet on the 30th June, 1886. The ebb and flood currents through this cut have now a maximum of from 2 to 3.5 miles per hour, according to circumstances.

Stormy weather and low tides caused the dredge to lose twenty days in getting to its place of work and four days in returning from work. The fluidity of the dredged material required constant piling along the embankment of deposited material. A broken boom caused a similar delay of six days. After the cut was opened the dredge was imprisoned seven days in the cut by banks of sand that formed under its square

New River, N. C.



Scale of yards



AB = Channel proposed in 1882
KOTQ = -- -- -- 1885.
LN = -- cut 4.0 feet deep in 1886.
VW = -- -- to low water in 1886.

Surveyed by Asst. Engr. Reid Whitford, and reduced in the office of Capt. W. H. Bixby, U. S. Engrs, to accompany his annual report of 1886. W. H. Bixby

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down-stream end during ebb tide. In view of these misfortunes, and and the consequent of no profits to the dredge owner, the carefulness, thoroughness, and absence of complaint with which he continued to do the agreed work, reflects great credit upon Mr. Moore, and his foreman Mr. Lord, and deserves special mention.

In May and June a second cut was opened across Wright's Island, about 1 mile below Cedar Bush Cove Marsh. The available funds were not sufficient to complete this cut to a serviceable depth; but it was very desirable to open it down to low-water level so that the river and ocean currents might have a chance to scour it out to a useful depth while further appropriations were waited for.

The work was done by hired hand labor. Between the 31st of May and the 28th of June 2,707 cubic yards of marsh turf and mud were taken out, opening a cut 1,200 feet long, 30 feet wide, and from .1 to .5 foot deep at low water. The ends of this cut were opened out to a width of 75 feet to facilitate the entrance of the currents. At mid tides the water now flows through this cut with a velocity varying from 2 to 3.5 miles per hour. The probabilities of the desired scour are very great.

A water-gauge was kept during the progress of the work.

All the above work has been carried on with great vigor and thoroughness under the immediate supervision of Assistant Engineer Reid Whitford. His full report, including a brief history of past work upon this improvement, is herewith appended.

Recommendations for future work are as follows: That the present adopted project be completed so as to secure a channel of from 100 to to 150 feet width, and 5 feet depth, at low water, from the ocean up to the upper river, at a total expense of $30,000 in addition to the $189.76 available 30th June, 1886, to be appropriated in a single amount within the next year. Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant, will increase the cost of the work by about $2,000 per appropriation. Further improvement, so as to give a channel of greater depth or width, is not recommended at present. This improvement, once thoroughly completed, should be permanent.

This improvement, as regards cost and order of work, should be carried on as follows:

Three thousand dollars to secure a channel 30 feet wide and 4 feet deep through Wright's Island by dredging.

Two thousand dollars to extend the existing channel above the upper marsh upward through a few obstructing oyster beds by dredging.

Twenty-five thousand dollars to increase the dimensions of the above obtained channel to 100 or 150 feet width and 5 feet depth at low-tide by dredging.

This river is in the collection district of Beaufort, N. C.

Money statement.

July 1, 1885, amount available		$10,000 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$9,152 04	
July 1, 1886, outstanding liabilities	658 20	
		9,810 24
July 1, 1886, amount available		189 76
Amount appropriated by act approved August 5, 1886		10,000 00
Amount available for fiscal year ending June 30, 1887		10,189 76

Amount (estimated) required for completion of existing project........	$32,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	32,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., July 13, 1886.

CAPTAIN: I have the honor to make the following report upon the improvement of New River, North Carolina, for fiscal year ending 30th June, 1886:

GENERAL FEATURES.

This river is not long and has its beginning and ending in Onslow County, North Carolina. The depth of water at its mouth seemed to have been less than on any portion of the navigable length of it.

The stream flows through quite a fertile country, and much very fine timber is found in its vicinity.

It is especially noted for the extent of oyster grounds at and near its mouth, and also for the oysters of superior size and quality which abound there.

The improvement of New River will be especially beneficial to the people in that country, inasmuch as they are isolated from railroad facilities, and they look entirely to the river to furnish means of transportation for the products of their lands.

The chief impediment to navigation has been the low marsh lands and oyster rocks choking up the mouth of the river immediately at the ocean inlet.

Through the "oyster rocks" a narrow, shallow, crooked channel has existed, which the boats trading in the river have used with difficulty and uncertainty.

HISTORY OF THE IMPROVEMENT.

1855.* An act of the North Carolina legislature was passed incorporating and chartering a stock company for the improvement of the channel of the river through "the rocks" at the mouth.

It was intended to follow generally the natural courses of the channel, and it was to have been improved by widening and deepening it.

The State appropriated $10,000 for the work, and $20,000 additional was subscribed by private individuals.

Joseph Etheridge was elected president (he was afterwards succeeded by Lott W. Humphrey) and E. W. Ward secretary and treasurer.

The plant for the work consisted of a dipper-dredge and necessary scows, built at Jacksonville, N. C.

The work was under the immediate supervision of a Mr. Abert, civil engineer.

A considerable quantity of material was excavated and some improvement accomplished, but the money being expended and the war coming on, the company was disorganized and the scheme was abandoned.

It was expected by the company to derive dividends from their investment by collecting toll from passing craft, the amount charged to be governed by their tonnage.

1881. Act of Congress of March 3, 1881, provided for a survey of the river. Upon the death of Capt. Charles B. Phillips, Corps of Engineers, United States Army, June 14, 1881, Capt. James Mercur, Corps of Engineers, United States Army, assumed control of the work.

1882. The survey was made under the direction of Capt. James Mercur in January of this year.

He estimated the improvement to cost $40,000, and his project contemplated widening, straightening, and deepening the old channel route known as "The Rocks."†

An act of Congress of August 2, this year, appropriated $5,000 for the work, but Capt. Mercur did not think it advisable to begin on so small an amount.‡

1884. Captain Mercur was succeeded by Capt. F. A. Hinman, Corps of Engineers, United States Army, in March of this year.

An act of Congress of July 5 appropriated $5,000 for the work, making in all available $10,000.§

Captain Hinman was succeeded by Capt. William H. Bixby, Corps of Engineers United States Army, in August.

1885. Captain Bixby recommended‖ that the proposed project be carried out with some modifications as to location of the line of work.

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* This information was furnished by Dr. E. W. Ward, of Onslow County, North Carolina.

† See Annual Report of Chief of Engineers for 1882, page 1117.

‡ See Annual Report of Chief of Engineers for 1883, page 865.

§ See Annual Report of Chief of Engineers for 1884, page 1046.

‖ See Annual Report of Chief of Engineers for 1885, page 1082.

In July this year an examination of the ground was made, with this change in view, by Reid Whitford, assistant engineer, under Captain Bixby's direction. He reported that a line could be located as desired, and recommended a survey to be made preparatory to staking off the work. In November the same year the survey was made by the said assistant engineer and the line of the proposed dredging staked off. This new line ran through the marsh land, straight from a point near the inlet and seemed to be better adapted to the successful accomplishment of the desired project than the old proposed route. The direction of the line, &c., was plainly shown on a map forwarded with the report on the survey.

1886. A contract was entered into with Rittenhouse Moore, of the Mobile Dredging Company, and the work of excavating the cut 45 feet wide and 4 feet deep at mean low water was begun at the upper end of the line on March 1, 1886.

As the work progressed the dredge was delayed by quicksand, shells, and caving banks.

Short sheet piles driven along the cut had to be resorted to by the contractor to hold back the excavation.

The material for the most part was thrown on one side of the cut, but it occasionally became necessary to throw some of it on the other side to prevent the banks caving.

The dredge completed the cut on May 17, having removed a total of 32,284 cubic yards of material. It was sent back through the cut to remove some caves, but could not do it, because the velocity of the current caused an eddy behind her, which deposited so much sand as to prevent progress in either direction.

After some difficulty the dredge was extracted from the cut, and left New River on the 27th of May, 1886.

The accompanying letter of Inspector Martin explains in detail the present condition of the cut.

After the dredge left, a cut 30 feet wide was made across Wright's Island by hand. From this there were removed 2,707 cubic yards. This work was suspended on the 26th of June last, owing to the exhaustion of funds. The accompanying letter and profile of Inspector Martin's* fully describes the present condition of Wright's Island Cut and what is left to be done there.

RECOMMENDATION FOR NEXT YEAR'S WORK.

It is respectfully recommended that the cut be deepened to the desired depth, and widened if it is deemed necessary—at least all caves be removed.

COMMERCE.

The commerce during the past year has probably been as large as usual, and has been carried on by sailing vessels.

The work thus far seems to have been an entire success, and will greatly aid navigation on the river.

Much praise is due Inspector Martin for the faithful and correct manner with which he has performed his duties, and Mr. John A. Dill, overseer of the work through Wright's Island, managed his hands so well that he got a large amount of work done in a short time. Much praise is also due him.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

L 7.

IMPROVEMENT OF THE CAPE FEAR RIVER ABOVE WILMINGTON (FROM WILMINGTON TO FAYETTEVILLE), NORTH CAROLINA.

The Cape Fear River, above Wilmington, has a total length of about 400 miles, and a drainage area of 7,167 square miles, of which 5,620 square miles lie above the mouth of the Black River, its main tributary. At Fayetteville, 112 miles above Wilmington, and the present head of navigation, the river varies from 112 feet breadth, 16 inches average depth, 150 square feet cross-section, 1 mile per hour current, and 200 cubic feet discharge per second in extreme droughts, up to 1,400 feet breadth, 50 feet maximum depth, 7 miles per hour velocity, and 350,000 cubic feet discharge per second in high freshets. Extreme low water usually lasts from two to four months per year, and 15-foot stages of water are usually reached once a month during the rest of the year. This river when placed under governmental improvement in 1881, was navigable during the nine flush-water months of the year from Wilmington, 112 miles, upward to Fayetteville; but the channel for the upper 75 miles was badly obstructed by sunken logs, snags, overhanging trees, and shoals; and for the upper 66 miles, it was full of shoals on which there was not more than 12 to 14 inches of water during the low-water season. At that time the navigation was owned by private parties. Its commerce is estimated to have then been about $800,000 of goods transported per year.

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* Omitted.

The original project of 1881–'82, as continued to date, proposed to buy out the private owners of the river for $10,000; then to clear out its natural obstructions for $43,125 (including superintendence); and to further provide a continuous channel over its upper 66 miles by $6,900 of dredging, and by artificially contracting its water-way by jetties through at least thirty-two shoals at an unstated cost (estimated by the same person in 1872 at $522,720) making practically a total of $582,745 for the final cost of this improvement. The aggregate amount appropriated for this project up to 30th June, 1886, is $65,000. During the last year the progress of the work has been examined, compared with the original estimates, and new estimates made. It was found that the natural obstructions were very numerous and difficult of removal, and the cost of their removal will exceed the original estimates. In the last four years 8,419 snags, 2,005 stumps, 2,327 logs, 2,205 trees have been removed from the river-bed, and 8,687 overhanging trees cut from its banks; but as many more remain to be moved. The violence of the freshets has proved too much for brush, log, or ordinary plank jetties, and in my opinion low stone jetties will prove the most economical in the end. The new estimates for the total cost of the work, $480,200, are as follows:

For clearing away obstructions:	
18,000 snags, at $1	$18,000
5,000 logs, at $2	10,000
2,500 stumps, at $3	7,500
3,000 cubic yards of rock, at $3	9,000
84,000 linear feet of rock jetties, at $3.50	294,000
Contingencies (10 per cent.)	34,600
Superintendence (10 per cent.)	34,600
Total required	415,200
Already spent upon this work	65,000
Total	480,200

There appears every probability that this expenditure will finally give 3 feet actual channel depth (30 inches free draught) over the whole river up to Fayetteville for eleven or twelve months per year, and that the commerce will be increased by that time to $4,000,000 of goods per year.

Sixty-four thousand five hundred thirty dollars and eighty-one cents has been spent in all upon this improvement up to June 30, 1886, giving a moderately well-cleared channel over the whole length of river, a moderately good continuous 4-foot channel during the entire year from

Wilmington 44 miles to Kelly's Cove, thence a similar 2-foot channel 26 miles further to Elizabethtown (a place of considerable commerce), and thence a similar 1-foot channel 42 miles further to Fayetteville; increased to 5-foot draught from Wilmington to Fayetteville during seven months of the year. In consequence three permanently-established steamboat lines have been running over the entire distance with full draught for seven months each year, and with lessened draught the rest of the time. The commerce during those years has increased about $200,000 per year, has been further benefited by exemption from tolls, and is now over $2,000,000 of transported goods per year, showing that each dollar spent on this improvement has been accompanied by the development of about $28 of annual commerce.

The navigation of this stream is not obstructed by bridges between Wilmington and Fayetteville.

The special work of the past fiscal year was as follows:

Expenditures, $5,516.98.

Owing to its variable features and the difficulty of properly specifying it beforehand and inspecting it afterwards, the work was allowably done by hired labor and the purchase of materials in open market.

Between the first July and the last of November, 1886, 41 stumps, 97 logs, 17 trees, 89 large snags, 630 small snags, and 680 cubic yards of hard mud have been removed from the upper 54 miles of river bed; 1 new sheet-pile jetty 40 feet long was built at McCarter's Cross, and another, 150 feet long, at Old Ferry; 1,438 cubic yards of rock and hardpan have been quarried, transported from 0 to 11 miles, and built into jetties at Fayetteville, McCarter's Cross, Old Jetties, and Old Ferry; stringers have been placed near low-water mark on the up-stream side of the old jetties at Fayetteville; maps of 22 shoals (15.6 miles of river bed) have been completed and 27,975 linear feet of jetties have been located thereon (including 2,553 feet already built). Twenty-two more less troublesome shoals remain to be surveyed.

The dead low-water level was established and permanently marked at various points along the river bank from Fayetteville 60.5 miles down-stream to tide-water at Whitehall, and a profile of this water-surface was made, showing an almost uniform slope of 4 inches per mile. The river was gauged at dead low water at several points from Fayetteville 41 miles down-stream to Elizabethtown, showing at Fayetteville as little as 150 square feet of cross-section and 200 cubic feet discharge per second, and at Elizabethtown an increase of only about 50 per cent.

A water-gauge was kept during the progress of the work.

The Government steam-launch has done all the towing and other service of the working parties upon the river, and, in my opinion, has well repaid all she has cost during the year, including her repairs. She is the only boat that can run on this river during dead low water. For economy and effectiveness during the next season's work she should be provided with a new and larger boiler and twice as powerful machinery.

Work has been much delayed by very low water (as low as 12 inches) and by high freshets (as high as 42 feet).

All field work was stopped in November for want of funds.

The effect of the 2,553 linear feet of jetties so far constructed has been to better the channel and the river at and near Fayetteville and at the other worst places, and to add one month to the duration of low-water navigation, now averaging 9.5 months per year.

All the above work has been carried on with great vigor and thoroughness, under the immediate supervision of Assistant Engineer Charles Humphreys, whose full report is appended.

Recommendations for future work are as follows:

Were the commerce of the river sufficiently large to justify the expendtiure of such an amount, in my opinion the proper method of improving this river would be by the construction of suitable dams and locks of 32 feet total lift, giving a 6-foot navigation at all times of the year to Fayettville, at a total cost of, approximately, $1,200,000. A commerce sufficient to justify such an expenditure cannot be expected from this locality for many years. In consequence, the lock-and-dam navigation must be postponed for the present and a contracted river channel accepted as the best under the circumstances. It is recommended, therefore, that this improvement be completed in accordance with the present approved and adopted project so as to secure a thoroughly-cleared 4-foot channel from Wilmington 70 miles to Elizabethtown; thence a similar 3-foot channel 42 miles further to Fayetteville during 11 or 12 months of the year, at a total expense of $415,000, in addition to the $469.19 available 30th June, 1886; this amount to be appropriated in yearly installments of about $60,000 yearly. Smaller yearly appropriations involving the alternate disorganization and reorganization of working parties, damage to unfinished work, deterioration of plant, and extra superintendence will increase the cost of the work from $1,000 to $4,000 per appropriation.

Further improvement so as to extend the navigation above Fayetteville, or so as to increase its depth below Fayetteville, is not recommended.

After this improvement is completed its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement as regards cost and order of work should be carried on approximately as follows:

Five-sixths of each appropriation to increase the draught at the shoalest and most troublesome points of the river by contracting the river channel by jetties at these points, such jetties to be so located in accordance with a predetermined systematic project for the entire river.

One-sixth of each appropriation to remove the most troublesome logs and snags in the river channel and to cut down and pull back the most troublesome leaning trees on the river banks.

This river is in the collection district of Wilmington, N. C.

Money statement.

July 1, 1885, amount available		$5,986 17
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$5,480 74	
July 1, 1886, outstanding liablities	36 74	
		5,516 98
July 1, 1886, amount available		469 19
Amount appropriated by act approved August 5, 1886		11,250 00
Amount available for fiscal year ending June 30, 1887		11,719 19
Amount (estimated) required for completion of proposed project		405,750 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		60,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for furnishing a steam-boiler, opened June 30, 1886, by Capt. W. H. Bixby, Corps of Engineers.

Names and address.	Description.	Amount.
H. A. Ramsey & Son, Baltimore, Md.	For a boiler to evaporate 100 gallons of water per hour into dry steam.	*$600 00
	For a boiler to evaporate 240 gallons of water per hour into dry steam.	*1,250 00
	For a boiler to evaporate 400 gallons of water per hour into dry steam.	*2,400 00

* Delivered.

Rejected. Prices too high.

REPORT OF CHARLES HUMPHREYS, ASSISTANT ENGINEER.

WILMINGTON, N. C., *April* 1, 1886.

CAPTAIN: I have the honor to make the following report on the improvement of the Cape Fear River, North Carolina, from Wilmington to Fayetteville, for the fiscal year ending June 30, 1886:

Operations in the field closed in November, when the plant was removed to Wilmington and turned over to the Lower Cape Fear watchman. The work has been confined to the removal of stumps, logs, snags, &c., from the bed of the river and overhanging trees from the banks; to the construction and repair of jetties; and to surveying, leveling, and mapping the river; and preparing projects for future work; gauging for discharge, and keeping a daily record of the water-surface.

Removed 41 stumps, 97 logs, 17 trees, 89 large snags, 630 small snags, 680 cubic yards of hard mud; stripped, quarried, and hauled to river-bank 1,438 cubic yards of rock and hardpan; loaded on scows and towed to jetties [from 2 to 11 miles] and sunk 1,234 cubic yards; removed at Old Jetties, from east side of river, and put on jetties on west side at that point, 277 cubic yards rock; reloaded at Fayetteville, on scows, and riprapped jetties there with 172 cubic yards rock; made bolts and put stringers on sheet-pile jetties Nos. 13, 12, 10, 8, 7, 6, 5, 4, and 3, at Fayetteville, the top of the stringers being about 2 inches or less above dead low water. [The present height of these jetties is about 4.3 feet above dead low water.]

Maps of Windom, Callahan's, and Melvine's were made and forwarded to you, also maps showing the effect of the jetties at Fayetteville, McCarter's Cross, Old Jetties, and Old Ferry.

The river was gauged between Fayetteville and Elizabethtown when it was at or near its lowest stage; drawings have been handed you showing these gaugings. The dead low-water line was permanently marked along the river-bank. A profile of the low-water surface has also been made, approximate levels being run from Fayetteville to Whitehall, 60½ miles below, where the tide swells slightly at dead low water.

The maps made and forwarded to you cover a length of 15.66 miles of river, and include the following shoals: Fayetteville, McCarter's Cross (1 mile below), Old Jetties (2½ miles below), Howard's (3 miles below), McRae's (5 miles below), Evans's (6 miles below), Rockfish (7 miles below), Smith's Cross No. 3 (8 miles below), Old Ferry (9 miles below), Thames (12½ miles below), Smith's Cross No. 2 (13½ miles below), The Dodge (20 miles below), Prospect Hall (21½ miles below), Windom (23 miles below), Callahan's (28 miles below), Kane's Gap (29 miles below), Purdy's (30 miles below), Melvine's Cross (31 miles below), Morehead (36½ miles below), McDowell's (38 miles below), Elizabethtown (42 miles below), and Elizabeth (42½ miles below).

Drawings have been made showing your "directions for future work" at all of these shoals, giving a total of 27,975 linear feet of jetties, 2,553 of this amount being built, including 791 feet of old log jetties rebuilt and repaired since October, 1884.

The snagging operations were carried on between Fayetteville and a point 54 miles below. The work generally has been greatly impeded by very low water, with about 12 inches in the channel, and violent freshets [at present the river is 42 inches above low water].

The small amount of jetty work done is shown in detail in the yearly-progress maps accompanying this report.*

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* Omitted.

The river was navigable for about a month longer in low water this year than last by the action of the jetties, exclusive of the aid afforded by the frequent freshets.

The deep water at the upper end of Fayetteville Shoals has been prolonged downstream about 600 feet, so that it is now 1,800 feet long. There has been a slight filling in the channel between Jetties 2 and 3. These two jetties are 400 feet apart, and leave 120 feet channel width. The lower end of Fayettville Shoal, where the jetties leave 80 feet channel width, is deepening, and I believe will have a good depth after this winter's heavy freshets.

The steamboats have been stopped a few days on account of the heavy freshets and ice, and two months on account of low water; in 1884 they were stopped about four months on account of low water. The following shoals remain to be surveyed: Old Flat (9½ miles below Fayetteville), Cedar Creek (11 miles below), Edward's Landing (14 miles below), Jno. Hare's (16 miles below), Gray's Creek, or Devane's Ferry (16½ miles below), Jackson's (17½ miles below), Sike's (19 miles below), Brown's Landing (43 miles below), Waddell's Ferry (44½ miles below), Phebus's (46½ miles below), Big Sugar Loaf (48½ miles below), Little Sugar Loaf (49½ miles below), Horse Point (50 miles below), Cypress (51½ miles below), Hammond's Creek (53 miles below), Slingby's (55 miles below), Mrs. Johnson's (56½ miles below), Whitehall (60½ miles below), Johnson's Timber Landing (61½ miles below), Donahoe (63 miles below), Robinson's Landing (64½ miles below), Brown's Reach (65½ miles below). These shoals allowing from 12 inches to 18 inches draught at dead low water do not give as much trouble to navigation as those under survey.

Should the present system of jetties be carried out on all the shoals, I think, from what I have seen of the river since 1884, that there would be a continuous navigation eleven months per year, at least for 30 inches draught.

The largest steamboat draws 26 inches without any freight, 5 feet when fully loaded; the other boats draw about 24 inches light; the flats draw 9 inches light, and every 100 bales of cotton puts them down about 4 inches; as long as there is sufficient water the boats and flats go fully loaded, and I believe if the river was improved the value of goods transported would gradually increase to $4,000,000 per year, including rafted goods.

The launch does all the Government towing, and is the only boat that can run on the river during low water; she needs new and more powerful machinery; her boiler is very old and has a great many soft patches on it.

The greatest known freshet was between 50 feet and 55 feet above dead low water at Fayetteville; the slope of the river at low water is about 4 inches per mile; dead low-water discharge at Fayetteville about 200 cubic feet per second.

Very respectfully, your obedient servant,

CHAS. HUMPHREYS,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

L 8.

IMPROVEMENT OF CAPE FEAR RIVER, BELOW WILMINGTON, NORTH CAROLINA.

The Cape Fear River, emptying into the Atlantic Ocean at Cape Fear, has, from its mouth up to its headquarters in the mountains, a total length of about 426 miles and a drainage area of 9,115 square miles. The two main branches of the river meet at Wilmington, bringing with them an average fresh-water discharge of 14,000 cubic feet per second. Below Wilmington the river is a tidal basin, with about 26 miles length, 350 square miles drainage area, 37 square miles water-surface, 3.5 feet rise of tide (2.5 at Wilmington, 4.5 at the ocean) and an average discharge during ebb of 160,000 cubic feet per second, the ocean bar being 2 miles seaward of the river mouth. The Cape Fear River below Wilmington, when placed under governmental improvement in 1829, had 3 bar entrances with least depth as follows: About 9 feet at the Baldhead Channel, 9 feet at the Rip Channel, and 10 feet at New Inlet Channel, these bars being, respectively, 9, 6, and 2 miles below the point which was then the river's delta. From the head of this delta 20 miles, up to Wilmington, there were several shoals with a least depth of 7.5 feet at low water.

The original projects of 1827 to 1847 proposed to improve the upper 20 miles by dredging and by jetty contraction of the channel; $203,204.59 were spent during this time in increasing the depth upon the shoals to 9.5 feet at low water, equal to that at the bar entrances.

At or about this time, the shore at Fort Caswell, opposite Baldhead Point, was protected by stone jetties, under an appropriation for the preservation of fortifications.

The projects of 1852 to 1857 proposed to deepen the water at the main entrance by jetties at Baldhead Point, and by jetty and dike obstructions between Zeke's Island and Smith's Island, near New Inlet, and suggested the possible future necessity of closing New Inlet; $156,296.26 was spent during this time upon these works, never fully completed for want of funds. The great storm of 1857 almost completely destroyed the Zeke's Island work, and the storms of 1871 cut through behind the Baldhead Jetty (now termed the Woodbury Jetty), leaving it about 1,000 feet out at sea.

The project of 1870 proposed for $257,000 a crib-closure of the space (4,403 feet long) between Smith's and Zeke's Island (finished in 1873), to prevent further widening of New Inlet. The projects of 1870 to 1872 proposed for about $300,000 the complete closure of New Inlet (begun in 1875 and finished in 1881), in order to deepen the water at the main (Baldhead) bar entrance.

The projects of 1872 to 1883, as continued to date, proposed for $160,000 the extension of the New Inlet Dam 2 miles further down the stream, to prevent the further erosion of Smith's Island at the Swashes. The project of 1875, as continued to date, proposed for $36,000 the occasional use of dredging upon the outer bar to assist the tidal currents in gradually localizing, straightening, deepening, and fixing the bar entrances; $12,000 to obtain a 12-foot depth at low water, and $24,000 more to obtain a 14-foot depth. The projects of 1874 to 1881, for the 20 miles above New Inlet, as continued to date, proposed $960,000 to be used in dredging and occasional diking wherever necessary across shoals, so as to secure for $247,000 a 12-foot channel 200 feet wide, and afterward, for $713,000 more, a 16-foot channel 270 feet wide at low water, over this whole length. The aggregate amount of the original estimates for the existing projects of 1870 to date is about $1,713,000; that of the revised estimates to date is about $2,110,000, the difference being $400,000. This $400,000 excess during sixteen years is chargeable, about $300,000, to unexpected engineering difficulties (such as presented by the excessive settling of foundations at New Inlet Dam, the necessity of raising this dam above high-water level, and the discovery of a forest of submerged stumps in the way of the desired dredged channels in the river-bed near Wilmington, &c., the necessity of a training-wall at Snow's Marsh Channel), and the other $100,000 to the inadequate yearly appropriations (involving loss from damage to unfinished work, care of property, extra superintendence, and deterioration of plant while awaiting funds, extra surveys, &c.). The present estimate, $2,110,000, for the final cost of the work exceeds that of last year by about $28,000, due partly to the consideration of a shoal in the river in front of Wilmington not heretofore estimated for, and the rest to the omission of the usual yearly appropriations for the last fiscal year (involving losses as above enumerated). The aggregate amount appropriated for the existing projects of 1870 to 1882 up to the 30th June, 1886, is $1,702,500.

One million six hundred and ninety-eight thousand four hundred and eleven dollars and seventy-four cents have been spent in all up to 30th June, 1886, upon the proposed improvements of 1870 to 1882, with great success, obtaining a 13.5 to 14 foot least depth of water at the main bar entrance, and completing to partial width the desired 16-foot channel 28 miles further, to Wilmington. This depth, combined with the average rise of tide of 4.5 feet at the bar and 2.5 feet at Wilmington, is such that, at present, vessels loaded to 16 feet draught can readily go from Wilmington to the ocean in a single tide any day of the year.

The total commerce, exports and imports, foreign and coastwise, has increased from about $13,400,000 of transported goods in 1870 up to about $17,000,000 in 1886 (all this increase being foreign commerce), showing that each dollar spent on this improvement has already been accompanied by the development of about $2.40 of annual foreign commerce, although the last increase of 2 feet in draught in the river-channel is too recent to have produced its natural effect on such development.

The navigation of this river below Wilmington is not obstructed by bridges of any sort.

The special work of the past fiscal year was as follows:

Expenditures, $66,052.81.

As far as possible all work has been done by contract.

At the shoals.—From July, 1885, to February, 1886, under an unfinished contract with Mr. Rittenhouse Moore, the work of dredging was continued at the Brunswick River, Big Island, and Lilliput shoals, and Snow's Marsh Channel. Three hundred and twenty-five thousand four hundred and forty-nine cubic yards of sand and mud, 118 large stumps, and 5 logs were removed from the river-bed so as to complete a channel through all of these shoals and marsh about 6 miles long, at least 16 feet deep at low water, 111 feet wide everywhere, and 148 feet wide at the bends. The several reaches of this channel were all marked by means of high guide piles driven in the river and large range-targets erected on the neighboring shore. Further work was prevented by want of funds.

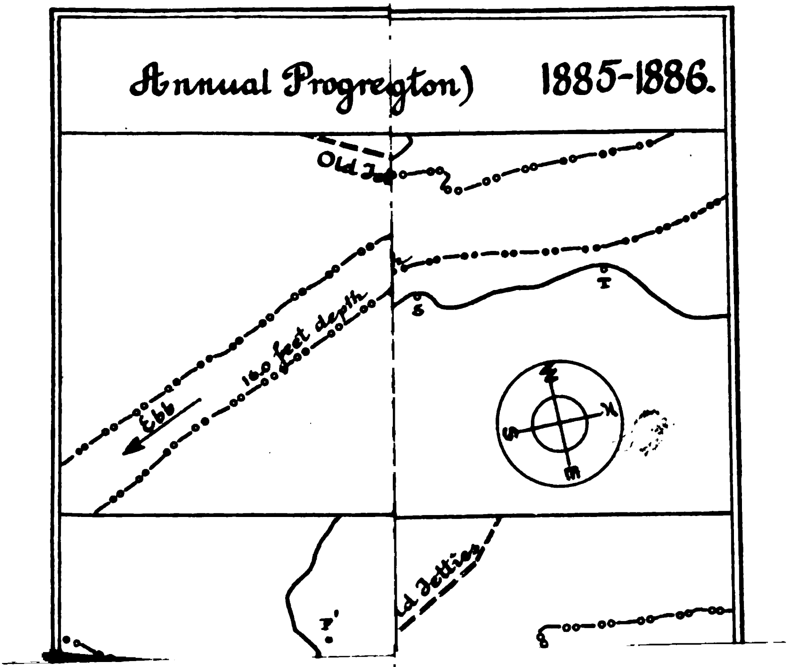
At the dike.—During July, under an unfinished contract with Mr. G. Z. French, 644 tons of heavy stone were received. This stone was placed in position upon the dike extending southward from Zeke's Island, thus raising the dike everywhere to ordinary high-water level and making it of nearly uniform strength throughout. Further work was prevented by the want of funds. The heavy storms of August and October, 1885, sent the water about 5 feet over the top of this dike, damaging it considerably over 2 miles of its length by knocking down its central ridge to a level of about 2.5 feet below ordinary high water. Considering the unfinished condition of the dike, it is surprising no more serious damage was done. The dike was repaired as well as possible by a redistribution of the remaining stone. Twenty-two thousand more tons of stone are needed to complete this dike.

In the river.—From December, 1885, to June, 1886, a careful hydrographic survey was made of about 11 miles of the river to determine the condition of its shoals at and in front of the city of Wilmington, at each of the various places where channels have been dredged, and at the bar entrances.

At all places, except Snow's Marsh, this survey shows so slight a shoaling in the various dredged channels as to indicate that the river currents will be able of themselves to maintain the present channels at the depths as now dredged.

At Snow's Marsh the survey shows a tendency of the river and ocean currents to cut across and through the shoal between the Snow's Marsh Channel and the old Horseshoe Channel.

At the main (Baldhead) bar entrance, the survey shows a decided tendency of the ebb current to cut a deep channel from Baldhead Point


Annual Progression 1885-1886.
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straight to the ocean. Along the line of this possible straight channel the bar has already deepened to 11 feet least depth, and is now only 650 feet long at 14 feet depth and only 1,400 feet long at 18 feet depth. A little assistance by dredging during the coming year might enable the ebb current to secure at once a straight 14-foot channel direct to the ocean, increased perhaps to 15 or 16 feet permanent depth along this line. The existing channel of 13.5 to 14 feet least depth at mean low water is in a far better condition than last year, as it now has as much as 350 feet least width, and now makes but two courses from Baldhead Point to the sea.

Upon the various beaches around Smith's Island and the river's mouth the gradual changes of the past year show favorable results almost everywhere, as follows: Federal Point, Caroline Shoal, and Zeke's Island considerably increased in extent; New Inlet rapidly shoaling and now almost closed; the "Swashes" continuing to close upon each other and upon the neighboring parts of Smith's Island so as to strengthen themselves and re-form about 1,000 feet to the westward of the former ocean-beach line, thus tending to form a solid and continuous breakwater between the ocean and the new dike; Baldhead Point commencing to re-form its former shore line out to the old Woodbury Jetty; Baldhead Point Hook lengthened and broadened and its inner basin shoaling, and Oak Island and its channel hardly changed.

A large and expensive plant of steamboats, hoister, and scows has been cared for as well as is possible when such a plant is not in use, but the damage from unavoidable rot, rust, and general decay, due to the lack of appropriations for active work, will probably exceed $7,000.

All the above work has been thoroughly and vigorously carried on under the immediate superintendence of Assistant Engineer Henry Bacon, whose full report is appended.

A carefully condensed history of past work upon this improvement was prepared by myself and forwarded in December of the past year. A copy of the text is appended.

Recommendations for future work are as follows: That the above improvements be carried on as originally projected, by completing the unfinished dike south of Zeke's Island, so as to thoroughly secure Smith's Island from further erosion by the ocean; and by widening and deepening the existing river channels to their full dimensions of 270 feet width and 16 feet least depth at low water; and by further protecting them against subsequent deterioration by submerged stone dikes where necessary, and by straightening, deepening, and fixing the bar entrance, at a total expense of $407,000 in addition to the $4,808.26 available June 30, 1886, this whole amount to be appropriated in one sum during the next fiscal year. Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, deterioration of plant, and extra superintendence, will increase the cost of the work by from $6,000 to $20,000 per appropriation. So far as can be seen at present, the above will complete all existing projects for this improvement.

After the improvement is finished its proper maintenance may cost from $5,000 to $15,000 per year, for a few years, but the improvement should be fairly permanent.

This improvement as regards cost and order of work should be carried on approximately as follows, (prices, including superintendence and contingencies):

Eight thousand four hundred dollars for the thorough repair of suction-dredge, steam tug, and scows.

Fourteen thousand four hundred dollars for the operation of the suction-dredge 12 months upon the main bar entrance.

Sixty-eight thousand seven hundred dollars for the completion of the dike extending from Zeke's Island southward to Smith's Island.

Nine thousand six hundred dollars for dredging through a shoal in the river in front of the city of Wilmington.

One hundred and ninety-eight thousand dollars for increasing the present narrow 16-foot depth dredged channels to their full proposed width of 270 feet.

One hundred and eight thousand dollars at Snow's Marsh, to permanently secure the present depth at this point, either by a dike to protect its eastern bank from wearing down, or by suitable dredging.

This river is in the collection district of Wilmington, N. C.

Money statement.

July 1, 1885, amount available		$70,141 07
July 15, 1885, amount received from sales to Beaufort Harbor		720 00
		70,861 07
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$65,124 33	
July 1, 1886, outstanding liabilities	925 48	
		66,052 81
July 1, 1886, amount available		4,808 26
Amount appropriated by act approved August 5, 1886		157,500 00
Amount available for fiscal year ending June 30, 1887		162,308 26
Amount (estimated) required for completion of existing project		265,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		265,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

HISTORY OF PAST WORK—IMPROVEMENT OF THE CAPE FEAR RIVER BELOW WILMINGTON, NORTH CAROLINA. (BY CAPTAIN W. H. BIXBY.)

GENERAL FEATURES OF THE RIVER.

The two branches of the Cape Fear River meet at Wilmington. They bring down to Wilmington a fresh-water discharge of about 500 cubic feet per second on an average during the three low-water months, and about 18,500 cubic feet per second during the nine flush-water months, or about $14,000 cubic feet per second on an average throughout the entire year. At Wilmington the river has a cross section of about 14,000 square feet, so that the height of its water-surface at this point remains approximately unaffected by the variations in the amount of the fresh-water discharge. Both branches are subject to tidal influence for a distance of about 30 miles above Wilmington.

From Wilmington to the ocean, 26 miles, the Cape Fear River is a tidal-basin of about 37 square miles area, in which the tide rises and falls about 2.5 feet at Wilmington and 4.5 feet at the ocean, or about 3.5 feet on an average. At the river's mouth, 1.25 miles wide, the amount of water which must pass to and fro each tide is therefore about 160,000 cubic feet per second. The ocean bar is about 2 miles to the seaward of the river's mouth.

ORIGINAL CONDITION, PRIOR TO IMPROVEMENT.

The improvement of the Cape Fear River below Wilmington has been under the consideration either of the State of North Carolina or of the United States since 1821.

Prior to 1761 the Cape Fear River was reported as allowing vessels of 14 feet draught to pass over its main bar at low water and to enter the river by the same route as they follow to-day. In 1761, however, during a violent equinoctial storm of four days' continuance, the wind and sea made a breach, reported at first as 18 feet deep at high water, and later as not over 2.5 feet deep at low water, and nearly half a mile wide, through the sand-banks into the Cape Fear River about 8 miles above its former bar entrance, at a place called Haulover. This breach, cutting off 6 miles of the river's length, gradually increased in importance so as to form a new mouth to the river, deepening from 6 feet at low water in 1797 to 10 feet at low water in 1839, and received the name of New Inlet. The effect of this new mouth upon the river was to diminish the depth of water upon the main bar entrance from 15 feet in 1797 to 9 feet in 1839.

The past and present condition of these bars is shown in the following table, the depths being expressed in feet and being (according to the best attainable information) reduced to low water. (See three maps forwarded with original report in December, 1885, to Chief of Engineers.)

Name of author of map.	Date.	Main outlet.		New inlet.
		Baldhead Channel.	Rip or Bulkead or shoalest part of western channel.	
Edward Moseley	1733	14	8	Closed.
William Nimble	1738	10	4	Closed.
Joshua Potts	1797	15	8	6
Colonel Kearney, Topographical Engineers	1820	10.5	3	6.5
Captain Glynn, United States Navy	1839	9?	9	10
Pilots and others	1850	8	9.5	7
Coast Survey, Captain Maffit	1851	8	7	8
Coast Survey, Captain Maffit	1852	7.5	7	8
Coast Survey	1866	8	8	7.5
Do	1871	6.5	8	8
Do	1872	8	8	8
Do	1877	9.6	7.5	8
United States Engineers	1883	14	....	Closed.
Do	1885	14	....	Closed.

Prior to the opening of New Inlet, and even until 1839, Baldhead Channel was the natural and main entrance to the river. From 1839 to 1872 both the Rip and New Inlet were the main entrances, and the use of Baldhead was discontinued. Since 1872, and the closure of the New Inlet, Baldhead has again become the main channel, and has been gradually regaining its former depths.

In 1821, the date of the first detailed survey of the river, vessels of over 10 feet draught were obliged to lighter their cargoes 14 miles below Wilmington, 10 feet draught at high water, and 7.5 feet draught at low water, being all that could be carried from the point of lighterage up to Wilmington.

From 1822 to 1829 the State of North Carolina attempted to improve the channel between New Inlet and Wilmington, by dike closures of the minor channels, by jetty contraction of the main channel-way, and also by dredging across the shoals. A small amount of money (supposed to have been from $60,000 to $80,000) was spent in this way, with moderately good results.

In 1826–'27 the United States made a careful survey of the portion of the river from Wilmington to New Inlet and a partial survey of the river mouths.

In 1829, when the United States Government assumed active charge of the improvements, the river had three bar entrances with least depths about as follows: 9 feet at the Baldhead Channel, 9 feet at the Rip Channel (both near the old river mouth), and 10 feet at the New Inlet Channel; these bars being, respectively, 9, 6, and 2 miles below the point which was then the head of the river's delta. From the head of this delta 20 miles up to Wilmington there were several shoals with a least depth of 7.5 feet at low water.

HISTORY AND CHARACTER OF THE GOVERNMENT WORKS, THEIR COST, AND THE RESULTS OBTAINED THEREFROM.

From 1829 to 1847, inclusive, $203,228.92 were appropriated for improving the river between Federal Point and Wilmington. The projects of 1829 to 1847 proposed to carry on the dredging and jetty contraction of the channel in general accord with the principles already outlined by the State engineer. Two hundred and three thousand two hundred and four dollars and fifty-nine cents were actually spent during this time with moderately successful results, increasing the depths upon the shoals by about 2 feet, so as to obtain 9.5 feet at low water, a depth equal to that at the bar entrances.

At or about this time the shore around Fort Caswell, at the main river entrance, was protected by stone jetties, having in special view the preservation of the site of the fort and its shore lines, which were rapidly receding.

From 1852 to 1854 $160,000 was appropriated towards the improvement of the mouth of the river. The projects of 1852 to 1857 proposed to carry on this improvement by the use of jetties (afterwards built, in 1853–'55, by Captain Woodbury) to hold Baldhead Point, and of jetty obstructions to close the small inlets through Zeke's Island and further east between Zeke's Island and Smith's Island, on the south side of New Inlet; and they suggested the possible future necessity of closing New Inlet. One hundred and fifty-six thousand two hundred and ninety-six dollars and twenty-six cents were spent during this time in nearly completing these proposed works. The sea cut through behind the jetty at Baldhead Point in 1871, and the jetties south of New Inlet were nearly destroyed in 1857 by the great storm of that year. Meanwhile, the water on the Rip Bar entrance was temporarily deepened by about 1 foot, and on the Baldhead Bar entrance was shoaled for about 1 foot.

From 1870 to date $1,702,500 were appropriated for the improvement of the river both at its mouth and above as far as Wilmington. For the mouth of the river: The projects of 1858 to 1872 proposed the reclosure of the space (4,403 feet long) from the head of Smith's Island to Zeke's Island. The projects of 1870 to 1872 proposed the complete closure of New Inlet (begun in 1875, finished in 1881). At the completion of these proposed works the least depth of water upon the main entrance (Baldhead) was found to be 13 feet at low water. The pro ject of 1875, as continued to date, proposes the occasional use of dredging upon the outer bar to assist the natural action of the tidal currents in the gradual localizing, deepening, and fixing of the bar entrance. Projects of 1872–'73, as continued to date, proposed the extension of the New Inlet Dam 2 miles further down the stream to prevent the further erosion of Smith's Island at the Swashes. For the 20 miles above New Inlet: The projects of 1874–'81, as continued to date, proposed dredging wherever necessary across shoals, so as to secure first a 12-foot channel 200 feet wide, and then a 16-foot channel 270 feet wide at low water, over this whole length. The latter depth, combined with the average rise of tide on the bar (4.5 feet) and at Wilmington (2.5 feet), will give a good 18-foot navigation at high water from the ocean to Wilmington.

One million six hundred and thirty-two thousand three hundred and fifty-eight dollars and ninety-three cents have been spent in all up to June 30, 1885, upon the proposed improvements of 1870–'82, with complete success, obtaining a 14-foot least depth of water at the main bar entrance, and completing to partial width the desired 16-foot channel 28 miles further to Wilmington. The lighterage, formerly a necessity over 14 miles of the river, is now entirely given up, and all vessels that can cross the outer bar now proceed directly to Wilmington to unload. So far as possible all the work of improvement has been done by contract.

The foreign commerce has increased from about $1,500,000 exports (see official statistics in Annual Report of 1874) in 1871, to about $5,000,000 exports in 1885. The total commerce, exports and imports, foreign and coastwise, is now about $18,000,000 of goods per year.

ANNUAL APPROPRIATIONS.

The annual appropriations for this work have been as follows:

By the State of North Carolina:	
1822 to 1829, unknown, estimated at	$70,000 00
By the United States:	
1826, for surveys (about)	1,000 00
March 2, 1829	20,000 00
April 23, 1830	25,688 00
March 2, 1831	25,705 00
July 2, 1832	28,000 00
March 2, 1833	28,000 00
June 28, 1834	5,234 00
March 3, 1835	20,000 00
July 2, 1836	20,000 00
March 3, 1837	10,000 00
July 7, 1838	20,000 00
March 2, 1847 (deficiency)	601 92
Total, 1829 to 1847	203,228 92
August 30, 1852	20,000 00
July 22, 1854	140,000 00
Total, 1852 to 1854	160,000 00
July 11, 1870	100,000 00
March 3, 1871	75,000 00
June 10, 1872	100,000 00
March 3, 1873	100,000 00
June 23, 1874	150,000 00
March 3, 1875	150,000 00
August 14, 1876	132,500 00

By the United States—Continued.	
June 18, 1878	$160,000 00
March 3, 1879	100,000 00
June 14, 1880	70,000 00
March 3, 1881	140,000 00
August 2, 1882	225,000 00
July 5, 1884	200,000 00
Total, 1870 to 1885	1,702,500 00
Grand total by United States from 1829 to 1885	2,065,728 92

These appropriations rarely, for an individual year, equaled the estimates of the Engineer in charge. The lack of sufficient funds, just at moments when these funds were most needed, has caused to the work a considerable loss of both time and money. The progress of the work has thereby been much hampered and the development of the river and harbor commerce much retarded.

EXPERIENCE GAINED EITHER BY SUCCESS OR FAILURE.

The work of 1822 to 1829 by the State, under Mr. Fulton as chief engineer, deepened slightly the water in the main channel and was of especial value as being the commencement of an important river improvement. Amongst the works constructed by him, one dike, that between Big (or Campbell's) Island and the mainland on its west, was expected to force the current to scour a channel east of that island; but this scouring took place very slowly, and the expected results were not finally attained, because of the existence in the desired channel-way of a large quantity of logs and stumps. These logs and stumps have had to be removed since at great expense.

All work subsequent to 1829 has been done by the United States.

The work of 1829 to 1847, other than being successful, possessed no features of special interest. The eight jetties, constructed under the plans of Captain Bache, resulted in material improvement to the navigation. During this interval the depth of water in the main channel increased by about 2 feet.

The work of 1852–'57 around New Inlet was tentative, and though not permanently successful was valuable as indicating a solution suggested by the Board of 1853 and recommended by that of 1858, viz, the closing of the minor and accidental outlet and the concentration of the main volume of the river outflow into the original and natural main outlet.

The jetty, 300 feet long, constructed by Captain Woodbury in 1853, at Baldhead Point, has remained in tolerable permanent condition up to to day (1885), although its shore end was flanked by the sea in 1871, and although it now stands under water and nearly 1,500 feet in advance of the present shore-line. Between the jetty and the shore the water still remains quite shoal. This jetty was originally built to protect Baldhead Point against further and rapid erosion by the waves and currents. It appeared to accomplish that object until 1870, the date of commencement of work at New Inlet. Its effect, if any, upon Baldhead and the Rip Channel cannot be stated with certainty.

The work of 1870–'73, that from the head of Smith's Island westward to Zeke's Island, and the experimental jetty or deflector at Federal Point (commenced in 1873 and extended from Federal Point southwestwardly into the river, as recommended by the Engineer Board of 1872) showed the danger of scour (occasionally 12 feet deep) under loaded cribs with solid bottom, and around the advancing ends of dikes in process of construction, especially if the cribs or dikes are raised at first to full height. It showed also the advantage of open bottoms for such cribs. It indicated the method later used in the closure of New Inlet, viz, the use at first of mattress foundations and low submerged riprap dikes entirely across the place to be closed, to be followed afterwards by a gradual elevation of the entire dike, commencing always at the shore ends. It showed also the ease with which sand-banks can be raised several feet by planted sea-oats, by catch-fences, and by brush, and at the same time the necessity for further protecting such artificial banks against subsequent high storm tides and waves. The original closure from Zeke's Island eastward to Smith's Island, that of 1852–'57, was attempted by means of a continuous line of very heavy stone riprap, efforts being made to assist the rapidity of the construction by the temporary use of auxiliary perpendicular jetties or piles, sheet-piles, brush, and sand-bags. The second and final construction of 1870–'73 consisted of a continuous line of wooden cribs loaded with smaller stone. The cribs with vertical sides were used from motives of economy to avoid the necessity of excessive side slopes of stone-work, timber being cheap and stone expensive in this locality. Subsequent experience in the immediate vicinity of this work leads to the belief that the only error of the first method of 1852–'57 was a mistaken economy in the amount of stone riprap used. The final closure, 4,403 feet in total length, which was not actually commenced until the fall of 1870, was finished in 1873, at an approximate cost of $60 per linear foot, and with great success. The sea-beach to-day (1885) has moved away from it on both sides to a distance in many places of several hundred feet; and the least depth of water in the Baldhead Channel was about 9 feet at low water, in 1875, against 6.5 feet at low water in 1871. The 1871 survey showed Baldhead Point as receding. Subsequent surveys, while showing neither gain nor loss at the Rip Channel from 1871 to 1872, did however show a gain in the Baldhead Channel from 6.5 feet in 1871 to 8 feet in 1872, and to about 9 feet in 1875. These works were moreover needed as a preliminary step to the closure of New Inlet; but the latter's completion in 1881, together with the construction of the new dike from Zeke's Island southward to Smith's Island in 1883–'85, have rendered unnecessary the maintenance of that part of the old work which lies on the eastward (the ocean side) of the new dike.

In 1873–'74, a steam-propeller (Woodbury), of 145 tons burden was fitted up as a suction-dredge (with a double oscillating 10-inch cylinder engine, driving a 9-inch centrifugal pump, and with sand-bins of 40 cubic yards capacity), and proved so successful that it dredged sand in 8 to 14 feet of water upon the bar entrance in all kinds of weather at a cost of not over 16 cents per cubic yard. This steamer was afterwards remodeled and its suction-dredge apparatus much altered and improved. As altered, it worked more easily and rapidly than before, so as to dredge and pass through its bins as much as 656 cubic yards of sand in one day, at a cost of not over 15 cents per cubic yard. The usefulness of this dredge, however, is not to be measured merely by the quantity of sand passed through its bins, inasmuch as its drags loosen and stir up from the channel-bed a large quantity of material, which is carried directly into the adjacent deep water by the river and ocean currents.

The work of 1875 to 1881, upon the closure of New Inlet, deserves especial note, as it resulted in such complete success. At the inlet the coast line was being re-established, and a shoal, 1.5 miles long and several hundred feet broad at high water, now completely crosses the old bar entrance of the inlet. At the mouth of the river the least depth of water in the Baldhead Channel was 14 feet at low water in 1883 against about 9 feet at low water in 1875. This closure was made of moderately small stone riprap, laid originally on log-and-brush mattresses, and capped with carefully-placed heavy stone (weighing from ½ to 4 tons per piece); the small stone (one manstone) being used from motives of economy, and the large heavy stone being used as a protection against storm-waves. The log-and-brush mattresses were used from a desire to utilize the materials of the country, and because they were one of the elements of cheapness in the bid of the successful contractor.

These mattresses were made of pine logs cut in the creek near at hand, formed into rafts of proper dimensions, loaded with as much pine brush as they would carry, towed directly to their places, and sunk by stone thrown upon them from scows. The middle portion of the dam (a lengh of 3,600 feet) is from 75 to 120 feet broad at its base, and on an average of 37 feet high; its side slopes are 1 on 1.5 in the river side and 1 on 2 in the ocean side. The whole dam is 4,800 feet long, contains about 182,821 cubic yards of material, and cost, complete, about $498,000, or about $105 per linear foot, or $2.75 per cubic yard. At present there is a difference often of 2 feet and sometimes of 3.4 feet between the water-levels of its river and sea side. During the construction of the dike the scour around its base, due partly to the river current, and partly to the overfall, was so considerable, and the attacks of the teredo were so severe, that the log-and-brush foundations were to a great extent undermined or eaten up; in consequence, continual additions of stone riprap became necessary, so much so that practically the resulting foundations consisted to a great extent of small stones. In view of this later experience it would seem that the use of small riprap stone foundations from the commencement might have been simpler, quicker, more efficient, and cheaper than the use of the log-and-brush foundations, although the latter were originally suggested by motives of economy.

The work of 1883 to date, upon a dike from Zeke's Island southward to Smith's Island, is the natural sequence of the work just described. After the closure of New Inlet the river appeared to be seeking a second new outlet across Smith's Island Beach, south of Zeke's Island, through the so-called "Swashes" (made in the severe storm of 1877), and an experimental attempt was made in 1881-'82 to close one of these swashes by an inexpensive work of round piling, sheet-piling, sand-bag, and timber just in rear of the ocean front at the swash. A gale arising before the completion of the closure, the width and depth of the opening were so much increased that further attempts to complete the closure in this way were abandoned. The result of this unsuccessful experiment suggested the subsequent construction of a stone riprap dike closure along the neutral line between the ocean and the river, about 1.5 miles in rear of the ocean beach. This new closure, commenced in 1883 and already raised to above low-water level, is so far successful, and points to results similar to those that followed the closure of New Inlet. This dike, 11,600 feet long and 7 feet wide on top, rests almost everywhere on a brush-mattress foundation, in from 5 to 12 feet of water. The brush mattress was built in sections, each 60 (or less) feet wide, 2,610 (or less) feet long, and 12 inches in final thickness, and cost in place about 66 cents per square yard, or $2.65 per cubic yard. The mattress is loaded with 52,000 cubic yards of stone. The dike (foundation included) has cost so far $155,000, or less than $14 per linear foot. About 22,000 cubic yards more of stone are needed to complete this dike to the desired height (that of high spring tides) and to give it the desired side slope of 1 on 2.

The work of 1874 to date upon the river between its mouth and Wilmington has been that of dredging only, and though eminently successful in results, possesses so far no features of special interest, except perhaps the remarkable efficiency of the present clam-shell dredge in pulling enormous stumps from their original bed at the bottom of the river. In several parts of the river below Wilmington, at places 2,000 feet from the shore and where there is now 14 feet depth of water, stumps of trees, pine as well as cypress, have been found firmly imbedded in the river bottom in an erect position, apparently surrounded by the soil in which they originally grew. Several theories have been advanced to account for these strange facts, such as that the ground has subsided, or has been undermined since the death of the trees; but none of these theories are entirely satisfactory. The artificially dredged channel-ways of the upper portion of the river have as far as possible been located along the thread of the current of the supposed natural channel. In a few cases where cross-currents could scarcely be avoided a certain amount of filling has taken place, and either a certain amount of training-wall or dike will be necessary to assist the moving water in retaining the desired direction and present depth, or redredging must be occasionally resorted to; and the final solution will be determined by the relative cost of the two methods, as modified by the probability of future continued appropriations and the demands of navigation.

In some cases where one side or bank of the channel lies on soft material in danger of erosion, a certain amount of diking, jettying or ripraping may some day be needed to preserve the present sides or banks.

SUPERINTENDENCE.

The improvement of the Lower Cape Fear River has been considered and discussed: in 1853 by Commission of Coast Survey, Navy, and Army Engineer officers; in 1858, by a Commission of Coast Survey, Navy, and Army Engineer officers; in 1871-'72 and in 1882, by a Board of Army Engineers.

The work under the State of North Carolina was directed by Mr. Hamilton Fulton, State engineer; that from 1827 to 1838 was directed by Capt. Hartman Bache, Topographical Engineer, with Capt. George Blaney, Corps of Engineers, as assistant; those from 1835 to 1839 were carried on by Lieuts. J. K. Mansfield, Corps of Engineers, John S. Winder, First Artillery, Lieut. A. J. Swift and Capt. John McClellan, United States Topographical Engineers; those from 1855 to 1857 were carried on under Capt. D. P. Woodbury and Lieut. W. M. C. Whiting, Corps of Engineers; those of 1870 under Col. James H. Simpson, United States Engineers, with Mr. Walter Griswold as assistant; those from 1870 to 1884, under Lieut. Col. W. P. Craighill, United States Engineers, with Capt. C. B. Phillips as assistant until 1876, and Mr. Henry Bacon as assistant from 1876 to 1884; since 1884, under Capt. W. H. Bixby, United States Engineers, with Mr. Henry Bacon as assistant.

WILMINGTON, N. C., *December* 18, 1885.

REPORT OF MR. HENRY BACON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., July 24, 1886.

CAPTAIN: I have the honor to submit the following report of operations for the improvement of Cape Fear River from the ocean to Wilmington during the year ending June 30, 1886:

The failure of Congress to make any appropriation for the year prevented any undertaking of new work and the continuance of the work of the present project any further than was embraced in the unfinished contracts for dredging and stone, and the care and preservation of the finished work.

At the beginning of the present year a small amount of stone remained to be delivered to complete the contract of Mr. G. Z. French, which was done during July, 1885, to the amount of 644 tons of heavy stone. This was placed on the new long dam, which was being constructed as a defense against the swashes of Smith's Island. This work, which is more than 2 miles in length, has been fully described in former reports, and was left in substantially the same condition as at the last annual report. The severe storms of August and October, 1885, did some damage to the dam by washing down the narrow central ridge from the level of ordinary high water at spring tides to 2.5 feet below over the greater portion of the dam, and thus destroyed in some measure its present efficiency. It was repaired to some extent by replacing the stone in the lowest places; but the general height was diminished by at least 2 feet. This would have caused but little permanent damage, if the funds had been available for continuing and completing the dam, as the stone was not scattered much outside of the proper foundation of the finished work.

The dredging under the contract with Mr. Rittenhouse Moore was completed to the extent of the funds which were properly available for it in December, 1885, with the exception of a few stumps which were accidentally left behind, and were removed in February, 1886, and a small amount of dredging also being done in the removal.

The following are the amounts of work done monthly, with the total amounts at each location:

Date.	Dredging.	Stumps removed.	Logs removed.
	Cubic yards.		
July, 1885	49,405	86	4
August, 1885	84,752	4	0
September, 1885	51,803	12	0
October, 1885	34,566	13	0
November, 1885	52,723	0	0
December, 1885	51,902	1	0
February, 1886	798	2	1
Total	325,449	118	5
Amounts previous to July 1	321,925	261	5
Total amounts of contracts	647,374	379	10

The proposed width of channel on all the shoals is 270 feet.

The Brunswick River Shoal is about 5,000 feet in length in one straight reach. It is finished to 111 feet width.

The Logs and Big Island Shoal is about 8,500 feet in length, in four reaches of various lengths. It is finished to 148 feet width.

The Lilliput Shoal is about 11,000 feet in length in two reaches. It is finished to 111 feet width, and at the angle for a distance of 1,000 feet each way to a width of 148 feet.

All the dredging on the three shoals has been done to 16 feet depth at mean low water.

The Snow's Marsh Channel was dredged to 270 feet width and 16 feet depth at mean low water from August, 1881, to December, 1883. A considerable deterioration was very soon observed on the upper reach, over a great portion of its length, and a slight decrease in depth at one point for a short distance on the lower reach. The dredging done during the past year on this channel was for repairs. As stated in the last report, the causes of the shoaling were the extreme softness of the materials in and adjacent to the cut and the tidal currents which cross the channel at a slight angle both on the flood and ebb.

Two deep cuts were made along the center of the whole upper reach a distance of 5,500 feet, making a width of 74 feet, and a third cut was made on about 2,900 feet length, making a width of 111 feet. The dredging was done to fully 18 feet depth at low water to allow for the filling in from the sides of the soft material. The amount of dredging on the upper reach was about 100,500 cubic yards.

The shoaling on the lower reach of the channel was directly opposite the main opening known as the thoroughfare through the Snow's Marsh Islands, through which the tidal basin in the rear of the marsh is to a considerable extent filled and emptied. At this point 11,200 cubic yards of dredging was done to a width of 74 feet and 18 feet depth at mean low water and length of 700 feet.

There has been very little, if any, deterioration in the other dredged channels. The length of the several dredged channels is as follows:

	Feet.
Snow's Marsh Channel	12,800
Midnight Shoal Channel	7,400
Lilliput Shoal Channel	11,000
Logs and Big Island Shoal Channel	8,500
Brunswick River Shoal Channel	5,000
Total length	44,700

about 8.5 miles.

The amount of dredging done at the five locations named since the commencement of the present project in 1881, for a channel of 16 feet depth at mean low water and 270 feet width, is 1,877,344 cubic yards.

Three hundred and seventy-two thousand two hundred and seventy-one cubic yards of dredging was done on the Snow's Marsh Channel from September, 1874, to May, 1876, to make a channel first to 9 feet depth and then to 12 feet, at low water, and 200 feet width. This makes the total amount of dredging done to date 2,249,615 cubic yards excluding the comparatively small amount done in connection with clearing the stumps and logs from the Big Island and Logs Channel in 1874 and 1875, of which no record was made, as the work was done by the day.

During the past year the stumps and logs were extracted with comparative ease by the use of the ordinary bucket of the grapple-dredge after digging around them. In a few exceptional cases dynamite was used to shatter them before removal. On the whole, not so much trouble was caused or expense incurred in extracting the stumps as was expected, but the job would probably have been nearly as profitable to the contractor if no stumps or logs had been found. He was paid $40 for each stump or log of trees 12 inches and upwards in diameter, and nothing for smaller stumps or logs, except as he was paid for their dredging.

After the dredging was finished, the areas where stumps had been found or expected were thoroughly dredged over to the required depths to find any stumps or obstructions accidentally left behind. A few stumps were found, and were removed in February, 1886.

Since the dredging was done at the several shoals, careful and exhaustive surveys were made at each place, which proved that the work in general has been well and thoroughly done.

At different times from November, 1885, to February, 1886, an exhaustive hydrographic survey of the river in front of Wilmington was made and mapped on a large scale. This shows the exact position of the shoal, which extends from the confluence of the main and northeast branch to a point in the northeast branch about 2,000 feet above and in front of the city adjacent. It is proposed to cut a channel to 16 feet depth mean low water across this shoal, and an estimate is therefore appended.

The different reaches of all the dredged channels have been carefully marked by high range piles driven and shore marks erected.

An exhaustive hydrographic survey of the entrance and the river from the bar and entrance to Reeve's Point was nearly completed in June, 1886. The main points were determined trigonometrically with precision. All the soundings were located by one transit cutting on ranges previously located with accuracy. This method enables us to locate soundings as fast as they can be taken—even in shoal water—often six per minute. The soundings in less than 28 feet depth were taken with poles and greater depths with lead and lines. The distance from Reeve's Point to the outer bar is about 10 miles. The area over which soundings have been taken is about 15 square miles. The number of soundings located is about 23,000.

The work of the survey embraced all the shore lines where changes are occurring, including Federal Point, the new beach over the site of the Caroline Shoals, Zeke's and Smith's islands, and the beaches at the swashes, Baldhead Point, and Oak Island.

The weather has been remarkably unfavorable for the work during the last four months, and this has prevented the completion of the survey and map at the end of the fiscal year.

This is probably the most exhaustive and reliable survey of the whole entrance and bar and the portion of the river embraced which has ever been made as to the details of hydrography.

Some of the results will be exhibited on maps being prepared to accompany the Annual Report.

A very great improvement has occurred in the Baldhead Channel. It is now in a better condition than at any former time on record.

There is a wide and easily navigable channel across the bar and inner shoal from the sea to the deep water of the harbor, with a least depth of 13.5 to 14.0 feet at mean low water. The narrowest place, which is at the inner shoal, has a width of 350 feet, and at this point there is another passage of the same depth and 200 feet in width.

There is a small shoal between the two, on which the least depth is 12 feet. There are no short turns to be made in navigating the channel, as heretofore. The harbor inside of Baldhead Point can be made from the sea with two courses and 14 feet depth at mean low water.

The deep pocket referred to in former reports, which extends straight from opposite Baldhead Point past the inner shoals, is now within 650 feet of the deep water over the bar. That is to say, the 14-foot curve at mean low water on the sea-side and inside are about 650 feet apart. The 10-foot curves are about 1,400 feet apart. It is evident that the forces of nature tend to clear this passage through and should be artificially assisted. This can be done by the use of the suction-dredge Woodbury, which was successfully employed on the channel from April, 1879, to October, 1881.

An estimate for its repair and operation is appended. The condition of the entrance channel, as showing the good results of the improvement above, embracing the thorough closure of the new inlet and the partial construction of long dam, is very gratifying, and indicates a reasonable certainty that with the completion of the dam and a proper jetty system at the entrance a low-water depth of 25 feet could be attained by the force of the tidal currents to and from the great tidal reservoir. It is probable that the opening of the deep dredged channels in the river at Snow's Marsh and above does and will assist in the work by the acceleration of tidal motion and increase of volume.

A comparison of the present condition of the bar and entrance with that as shown by the survey and map of 1877 will show the great changes which have taken place, especially at the Baldhead Channel. In 1877 there was no well-defined channel at the bar, but a least depth of 10 feet at mean low water could be found in devious courses. From the somewhat elaborate Coast Survey map of Assistant W. I. Vinal, of 1872, it appears that only 8 feet could be carried across the bar, and there was the same depth available at the "Rip" of the western channel. The western or Oak Island Channel at the bar or inner basin appears to be in much the same condition as in 1872 and 1877. There is now, as then, about 14 feet depth at low water at the outer bar and 7 to 8 feet at the "Rip."

The changes in the shore-line of Oak Island are not great since 1877.

At Baldhead Point there has been a continuous erosion (misprinted "extension" in the last report) on the sea-side ever since the stone jetty was flanked in 1871, but the distance across the entrance to Oak Island has remained the same. The hook of the point has extended inward and beyond the light-house, and has thoroughly protected it. In previous years the light-house was in danger from the continuous erosion of the shore on the inside.

While Baldhead Point has been worn away on the sea-side, a large accretion has been going forward at the sea-shore southerly from the point, which is advancing with considerable rapidity towards the old stone jetty, which is still in sight at low water, while the shoal at the point is also tending towards the jetty. The prospect is that a hook may at last extend from the accretion first mentioned to the old jetty, and thus restore the point to its former condition.

The plotting of the survey is unfinished. Enough is done to show the condition of the channel from the bar entrance to Reeve's Point. The wide and deep channel from Baldhead Point to the Horseshoe Channel Shoal, opposite Price's Creek, and the harbor at Smithville, remain substantially as from the times of the earliest records.

The old channel, known as the Horseshoe, has been variable for many years. The Price's Creek Light-House range now leads across a dry shoal at low water, where the channel was in 1850-'55. At the present time the greatest depth available is 9 feet at low water, and the passage is so intricate as to make it difficult for navigation with 7 feet draught at low water. It is not in present use, as there is fully 14 feet available depth at low water throughout the whole length of the Snow's Marsh Channel, and 16 feet, excepting at one point, in the lower reach before mentioned. The dredging done in repair of the Snow's Marsh Channel from October to December 30, 1885, before mentioned, proves thus far more beneficial then could have been expected from former experience. Since then the most decided symptoms of deterioration are at the point in the lower reach last mentioned.

The passage between the marsh islands, before referred to as the source of this trouble, should be closed. It would require not exceeding 2,500 tons of stone riprap to bar the passage. There the tidal currents would then pass behind the islands to fill and empty the basin and Walden Creek, and would not interfere with the main channel.

Since the Snow's Marsh Channel has been opened there has been a tendency towards scouring passages across the high shoal above the Horseshoe, and between the old channel and the new, so that now there are two passages with fully 6 feet least depth at low water where there was less than 3 feet depth in 1877. These passages diverge from the new channel upward and are approximately parallel to the lower portion of the Horseshoe Channel.

It also appears that there has been considerable shoaling since 1877 in the deep water known as the Five Fathom Hole, opposite and above the head of Snow's

Marsh. In 1877 there were depths of 30 and 31 feet at low water, where now the greatest depths are 26 and 27 feet.

The middle ground between the upper reach of Snow's Marsh and the main channel at the Five Fathom Hole has continued to wear away, as stated in the last report, and this will tend to increase the cost of the proposed jetty if there be further delay in having available funds.

There has been very little change in the shore-lines of Federal Point and Zeke's Island during the year. The long beach extending over the site of the Caroline Shoals, from Federal Point Beach towards the head of Smith's Island, has widened and risen, and at the extremity has extended 500 feet nearer the head of Smith's Island, being distant now 1,000 feet at high water. It is also 250 feet nearer Zeke's Island, the opening being 1,250 feet of shoal water.

The swashes of the Smith's Island Beach remain open, with the exception of the northerly one, of the former reports, which is now entirely closed from natural causes and the construction of the new dam.

This was by far the most dangerous opening on account of its proximity to the main channel of the river. Its closure can be attributed with certainty to the partial construction of the new dam.

Before it was entirely closed, the beach at its northerly flank became quite narrow and weak, from constant receding at the swash, and was finally broken by the sea near the head of Smith's Island. From this breach, which has been greatly reduced, there remains a small opening of less than 100 feet width at low water and 200 feet at high water. This would be dangerous but for the dam. It will undoubtedly be closed on or before the completion of the dam.

The long narrow sand-hook which at the beginning of the year extended from the northerly side of the next or main swash, was flanked by the autumn storms of 1885, and its restoration is not fully completed, so that the width at high water is greater than at the beginning of the year, but the shoaling in the bay has increased.

The hook at the southerly side of the south swash was also flanked, making the opening wider at low water. The sectional area of all the swashes has not increased materially. The total widths at high water and low water are 4,050 and 2,780 feet against 2,930 and 1,700 feet at the beginning of the year.

The importance of completing the dam is apparent.

The series of projects which are now in the way of completion began with the appropriation of 1870.

The present project embraces the completion of the dredged channels across all the shoals where dredging is required to make 270 feet width and 16 feet depth at mean low water; the completion of the long dam from Zeke's Island to the Big Marsh; the construction of the jetty or training-wall at the head of Snow's Marsh for the preservation of the dredged channel; the repairs of the dredged channels by dredging where there has been deterioration; and the operation of the suction-dredge Woodbury on the Baldhead Channel.

In addition to these, it is proposed to dredge through the shoal at Wilmington before mentioned.

The following is the estimate of the amounts required for the completion of the projects.

It should be remarked that on account of the plant lying idle for more than a year, the deterioration has been rapid and much greater than it would have been if constantly employed. This is the case especially with the scows (14 in number) and the steamer Woodbury.

Eight hundred and ninety-seven thousand cubic yards of dredging to complete the channels to Wilmington, at 14.5 cents	$130,065 00
Removing 880 large stumps and logs, at $40	35,200 00
40,000 cubic yards dredging at Wilmington, at 20 cents	8,000 00
22,000 tons stone delivered to complete dam, at $2	44,000 00
Cost of labor, placing stone, at 60 cents per ton	13,200 00
41,680 tons stone delivered for jetty, Snow's Marsh, at $2	83,360 00
Cost of labor, unloading stone on jetty, at 15 cents per ton	6,252 00
Cost of 100 piles driven, at $3	300 00
Repairs of the suction-dredge Woodbury	4,000 00
Operation of the Woodbury, 12 months, at Baldhead Point	12,000 00
Repairs of the steam-tug James T. Easton	600 00
Repairs of 14 scows and pile-drivers	2,000 00
	338,977 00
Add 10 per cent. work and superintendence	33,897 70
Add 10 per cent. for contingencies	33,897 70
Total	406,772 40

I will forward with this a letter from Mr. C. H. Robinson, collector of customs, in which he states the amount of revenue collected during the last fiscal year, and gives other valuable information, also a statement of the commercial statistics of the port prepared with great care by Mr. A. H. Van Bokkelen, late president of the chamber of commerce, Wilmington, N. C. He deserves credit for the interest he has taken in the work and the public spirit he has for many years manifested.

The work is in the collection district of Wilmington, N. C. The nearest light-houses are at Baldhead Point and Oak Island, at the mouth of the river.

Respectfully submitted.

HENRY BACON,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

[Furnished by Mr. A. H. Van Bokkelen, ex-president chamber of commerce, Wilmington, N. C.]

	Vessels.	Tons.
Coastwise	274	113, 137
Foreign	186	79, 980
Total	460	193, 731

Exports and imports.

Articles.	Foreign.	Coastwise.	Total.
Cotton ... bales	73, 213	30, 651	103, 854
Spirits turpentine ... casks	43, 757	22, 140	65, 897
Rosin ... barrels	288, 499	44, 195	332, 694
Crude turpentine ... do	3	35, 439	35, 442
Pitch ... do Tar ... cases	9, 075	63, 542	72, 617
Sawed lumber ... feet	9, 053, 000	28, 729, 500	37, 782 500
Shingles ... number	1, 589, 000	8, 761, 500	9, 850, 500

1886, value of exports	$10, 330, 000
1886, value of imports	6, 000, 000
Total	16, 330, 000

LETTER OF THE COLLECTOR OF CUSTOMS AT WILMINGTON, NORTH CAROLINA.

CUSTOM-HOUSE, WILMINGTON, N. C., *July* 15, 1886.

SIR: In response to your verbal request I give you below the transactions of this office for the year ending June 30, 1886.

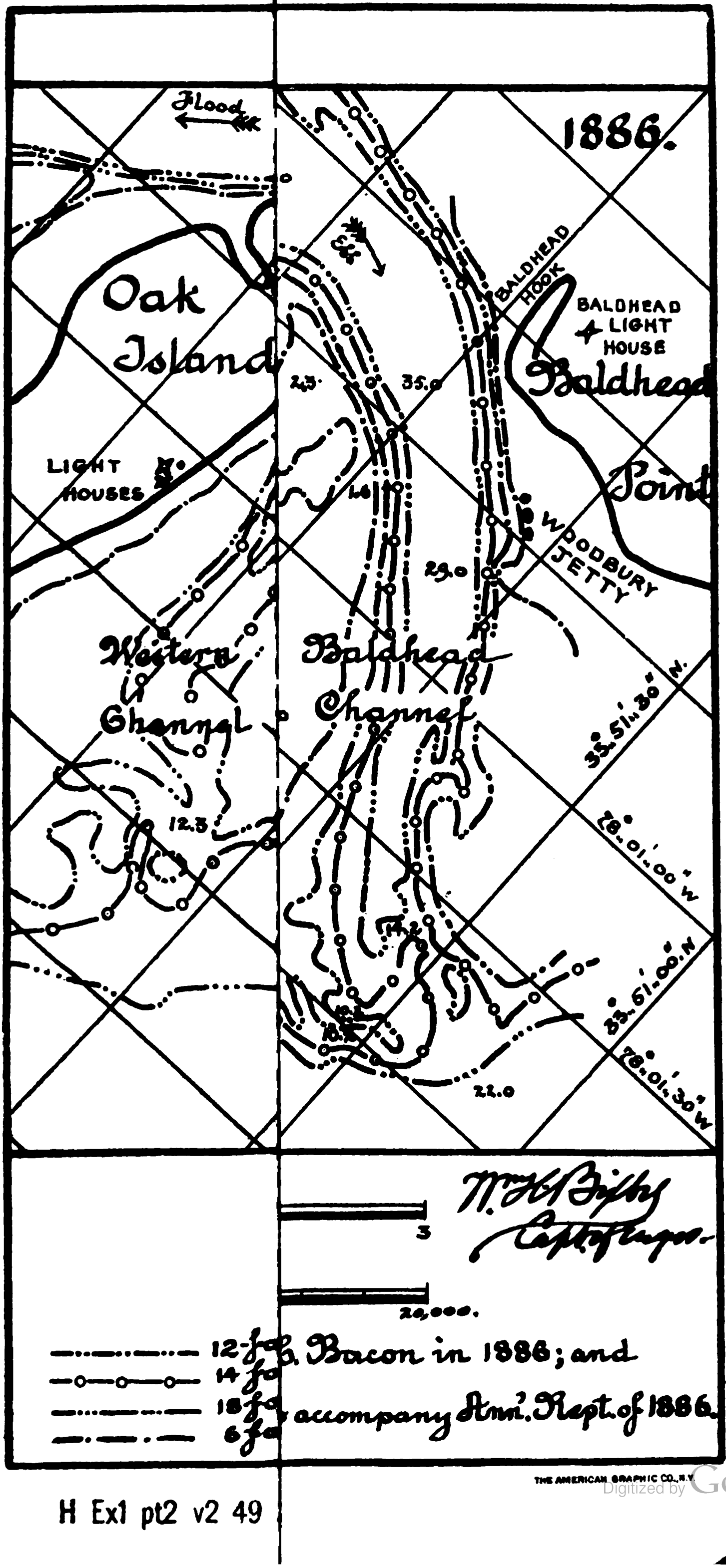
RECEIPTS.

Duties	$19, 837 38
Tonnage	3, 124 56
All other	2, 528 63
Total	25, 490 57

EXPORTS.

Domestic	$4, 390, 331
Foreign	
Total	4, 390, 331

Imports and warehouse entries	114
Entries, foreign	163
Clearances, foreign	186
Entries, coastwise	99
Clearances, coastwise	66
Vessels documented	54
Tons	7, 622. 62



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L 9.

IMPROVEMENT OF GREAT PEE DEE RIVER, SOUTH CAROLINA.

The Great Pee Dee River, emptying into Winyaw Bay at Georgetown, S. C., has (including its upper portion called the Yadkin) a total length of about 500 miles and a drainage area of 16,329 square miles, of which 9,642 square miles lie above the mouths of the Black, Lynche's, and Little Pee Dee, its main tributaries. At Cheraw, at a stage of 0.5 foot above low water, its discharge is about 7,000 cubic feet per second. This river, prior to governmental improvement in 1880, was dangerously obstructed with snags and logs everywhere. Otherwise it was easily reached at a point 41 miles above its mouth by 9-foot-draught boats coming by way of the Waccemaw and Bull Creek; thence it was navigable for the same boats 26 miles further, to Smith's Mills; and thence for 3.5-feet-draught boats at low water 88 miles further, to Little Bluff, or at high water 183 miles further, from Smith's Mills to Cheraw, the present head of steam navigation, 250 miles above Georgetown. The commerce of the river is estimated to have then been $400,000 of goods transported per year.

The original project of 1880, as continued to date, proposed for $25,000 to secure a thoroughly cleared 9-foot navigation to Smith's Mills, and a 3.5-foot navigation to Cheraw at all stages of water. This estimate was based on an examination required to be made hastily and inexpensively. As regards logs and snags, the estimate allowed for only 500 in all (two per mile on an average); whereas as well as can now be estimated over 1,000 logs and snags have actually been removed, and about 6,000 more are awaiting removal (in all, 32 per mile). Moreover, these logs are extremely large and their removal proportionately expensive. Inadequate yearly appropriations involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant have added considerable to the cost of the work. The aggregate amount appropriated for this project up to 30th June, 1886, is $27,000. The present estimate (that of 1885), $117,000 for the final cost of the work, is based on these later developments and personal examinations.

Twenty-six thousand nine hundred and nineteen dollars and forty-three cents have been expended in all upon this improvement up to 30th June, 1886, giving at all ordinary stages of water a well-cleared 9-foot navigation 67 miles upward, to Smith's Mills; and a fairly-cleared 3.5-foot navigation at low water 83 miles further, to the railroad station at Pee Dee, or, at high water, 183 miles further, from Smith's Mills to Cheraw. The commerce of the river has been thereby increased so as to be at present about $2,000,000 per year, showing that each dollar spent on this improvement has been accompanied by the development of about $59 of annual commerce.

The navigation of the river is obstructed at points, as shown by the following extract from special report, dated January 17, 1885:

> About 150 miles above Georgetown this river is crossed by the Wilmington, Columbia and Augusta Railroad, on a bridge provided with a draw-span of suitable width. Projecting iron work on the piers, swift cross-currents in the river, and an improperly arranged piling fender combine to subject passing vessels to injury.
>
> Several miles above the railroad bridge the river is crossed by the toll-bridge of the Society Hill Bridge Company on a through bridge provided with a draw-span of proper width. Swift and strong cross-currents and the absence of suitable fenders combine to subject passing vessels to injury by the bridge piers.

> I recommend that the owners of both these bridges be required to provide strong and suitable fenders at both ends of these draw-openings, these fenders extending 100 feet above and below the bridge, and rising above ordinary high water to within about a foot of the draw-span's lower chord.

The special work of the year is as follows:

Expenditures, $829.02.

Owing to its variable features, and the difficulty of properly specifying it beforehand and inspecting it afterwards, the work was allowably done by hired labor and the purchase of materials in open market.

A small survey was made of the river in June with a view of obtaining a map suitable for properly ordering and recording future work. This survey was very efficiently made by Assistant Engineer Charles Humphreys.

Other than this, and office work, and the care of the Government property, nothing has been done for want of funds.

The general charge of the work has been under the immediate supervision of Assistant Engineer Reid Whitford. His full report (including a brief history of past work upon this improvement) is herewith appended.

Recommendations for future work are as follows:

That this improvement be completed in accordance with the present approved and adopted project, so as to secure a thoroughly-cleared 9-foot navigation 67 miles upward, to Smith's Mills, and thence a 3.5 foot navigation 183 miles further, to Cheraw, at all stages of water, at a total expense of $90, 000, in addition to the $80.57 available the 30th June, 1886, this amount to be appropriated in two yearly installments of $60,000 and $30,000 respectively. Smaller appropriations will increase the cost of the work from $2,000 to $5,000 per appropriation. Further improvement, so as to extend the navigation above Cheraw, is not recommended for the present.

After the improvement is finished, its proper maintenance may cost from $2,000 to $5,000 per year to properly maintain the improved channel.

This improvement, as regards cost and order of work, should be carried on approximately as follows: The entire length of river should be examined and improved uniformly each year. During the low-water stage the most troublesome sunken logs and snags should be removed from the channel. During the high-water stage the most troublesome leaning trees should be cut down and pulled back from the banks, as also such trees on caving banks as appear liable to fall into the river channel during the following year.

This river is in the collection district of Georgetown, S. C.

Money statement.

July 1, 1885, amount available		$909 59
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$489 30	
July 1, 1886, outstanding liabilities	339 72	
		829 02
July 1, 1886, amount available		80 57
Amount appropriated by act approved August 5, 1886		20,000 00
Amount available for fiscal year ending June 30, 1887		20,080 57
Amount (estimated) required for completion of existing project		73,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		60,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 3, 1886.

CAPTAIN: I have the honor to make the following annual report upon the improvement of the Great Pee Dee River to date.

GENERAL FEATURES.

This river is merely a continuation of the Yadkin.

The latter river in Watauga County, North Carolina, flows first easterly, then southerly, taking the name of Great Pee Dee, at the mouth of the Uwharie River, a small stream entering from the northeast, in Montgomery County, North Carolina, and joins its water with the Waccemaw, a short distance above Georgetown, S. C. This river traverses. possibly, one of the most fertile as well as the richest sections in both States.

Beginning in the country where minerals of various kinds abound, and after passing the small grain, fruit, tobacco, and gold belts in North Carolina, it enters the cotton belt in the State of South Carolina, and finally ends in the tide-water rice-lands near the sea-coast.

The valley of the Yadkin is noted far and wide for its fertility of soil and healthfulness of climate, as well as for its picturesqueness of scenery and thrift of people.

Many thousands bales of cotton and bushels of rice are annually harvested from the Pee Dee Basin and shipped to distant points.

"The Narrows" of the Yadkin, found about 6 miles above the mouth of the Uwharie, presents a most picturesquely grand scene.

Here the water is abruptly contracted from a width of about 500 feet to that of probably 60 feet, causing the current to rush with marvelous swiftness between walls of beautiful slate rock which lie in a confused mass along the edges of the "Narrows," and at the foot of the nearly vertical uprising cliffs.

There are two perpendicular falls in the Narrows, said to be respectively 6 and 8 feet.

A visitor at this place is at once struck with the superior magnitude of the inexhaustible water power everywhere visible, and wonders why it has been allowed to remain thus idle for so many years.

The possible length of this river from head to mouth is near 465 miles, affording means of drainage for a tremendous area of land. The low-water surface of the river all the way from a point a short distance above Cheraw to its head, is broken at intervals by falls and rapids. At some places the falls are vertical, the river being dammed for milling or fishing purposes, and at others the water roars over steep rocky beds with great velocity. Below Cheraw the slope is less, and the river-bed is generally free from rock or gravel shoals. Steamers run regularly as far up as that town without the least difficulty when there is sufficient water to admit of their passage over the sunken logs or sand-bars. During the past several years the United States Government has been endeavoring to improve that section of the Yadkin River stretching from the North Carolina Railroad Bridge, near Salisbury, to Bean Shoals, near Wilkesboro', a distance of about 64 miles. The improvement contemplated blasting a channel through the rocks, where there was not sufficient water for a class of small boats. It is thought that at present the work has only been partially completed over the first 20 miles.

HISTORY OF THE IMPROVEMENT OF THE GREAT PEE DEE.

1784.* An act of the South Carolina legislature appropriated £300 sterling to be expended in the removal of all obstructions as far up as the North Carolina line.

1785.* An act of the same legislature to improve the river from Euhany Ferry (38 miles estimated from Georgetown) to the North Carolina line, funds for this purpose to be collected by levying a special tax upon the lands lying along the river.

1791.* An act to improve the river between points mentioned in 1785 by requiring the male inhabitants of the adjacent county to work each six days in the year at removing obstructions.

1805.* An act of this year appropriates $4,000 for the improvement of the river from Britton's Ferry to the North Carolina line.

1815.* An act of this year was passed which provided for the improvement of the North Carolina line down to Singleton's plantation by the six days' labor plan.

1873.† The river was examined by General Q. A. Gillmore, Corps of Engineers, this year.

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* Extract from back acts of South Carolina legislature.

† See Chief of Engineers' Report for 1873, page 753.

1878.* An act of Congress, approved January 18, 1878, provided for a survey of the Pee Dee River from Cheraw to the mouth of the Uwharie; distance 67 miles. The survey was made in December, this year, under the direction of Capt. Charles B. Phillips, Corps of Engineers, who only recommended that the first 20 miles above Cheraw should be improved.

1879. An act of Congress of March 3 provided for a survey of the river below Cheraw.† The survey was made under the direction of Captain Phillips in October of this year. He recommended that the improvement be undertaken over this part of the river, and that the sum of $25,520 should be expended in carrying on the proposed project, which contemplated removing the obstructions so that a depth of 9 feet at low water might be secured from the mouth of the river to Smith's Mills, and 3½ feet from that point to Cheraw.†

1880–'81. An act of Congress, approved June 14, 1880, appropriated $7,000 for this work.‡ An act of March 3, 1881, appropriated $6,000 more.§ H. Heth, assistant engineer, was placed in local charge early in the autumn of 1880.

Capt. James Mercur, Corps of Engineers, assumed control of the work upon the death of Captain Phillips, June 14, 1881. Work was begun at the "Pocket" landing with a hand-hoister, about 170 miles above Georgetown, 10th November, 1880, and between that date and the 30th of the following June (the work had been interrupted by high water) there had been removed from the river 286 logs, besides some small ones, and in addition the banks were trimmed of overhanging growth.‖

1881–'82. An act of August 2, 1882, appropriated $6,000 for this work. Work was resumed in July, 1881, on the upper part of the river, with a hand-hoister. Afterwards the steamer Marian (subsequently used on the Wateree) was employed as a steam-hoister, but proving too large and too deep for the river work her services were soon dispensed with and work was again carried on by hand. From July, 1881, to July, 1882, some logs were removed from the bed of the river and some overhanging growth cut.¶

1882–'83. Work was again begun in November, 1882, by a force of hands, trimming the banks of overhanging growth on the upper part of the river. A steam-hoister (Samson) also did some work between the mouth of the river and Smith's Mill, but ceased operations 9th February following. No detailed statement of amount of work done is given.**

1883–'84. Work was suspended March 3, 1883, and there was no appropriation during fiscal year ending June 30, 1884.††

Captain Mercur was relieved by Capt. F. A. Hinman in March, 1884. Reid Whitford, assistant engineer, took local charge of this work under Captain Hinman, May, 1884, vice H. Heth, assistant engineer, resigned.

Captain Hinman was relieved by Capt. William H. Bixby, Corps of Engineers, August 12, 1884.

1884–'85. An act of July 5, 1884, appropriated $8,000 for this work. Operations were commenced 7th October following at Fort Harrelson, and continued upwards to Tigerhead, a distance of about 160 miles. This hoister stopped work last day of October, and went direct to the Wateree River to do similar work for the United States. During the first days of next month a hand-hoister was converted into one of steam for the United States, and started work at Dick Nalum's Landing, 133 miles above Georgetown. This machine worked nearly over the entire lower part of the river, and was laid up for want of funds on the 30th of the following April. Early in February, 1885, a new steam-hoister, furnished by Skinner & Ferris, of Wilmington, N. C., was started at Cheraw, and when she was laid up, May 30 following, she had worked roughly over the whole length of the river. In this way there were removed during the fiscal year ending June 30, 1885, a total of 452 large logs from 1 to 5 feet in diameter and from 20 to 90 feet long, 152 stumps, 35 cords of snags, and 1 barrel of rosin from the bed of the channel, and 972 trees and 840 linear feet of brush cleared from the banks where they overhung and obstructed navigation.‡‡

Captain Bixby revised the estimates of the probable cost of completing this improvement, and recommended a further expenditure of $90,000, in order that the depth desired in the original project might be secured.§§

1885–'86. No work has been done since the end of the last fiscal year to date of this report, except an examination of the river, which was made in May, 1886. During the progress of the work, regular trained pilots of the South Carolina Steamboat Company for this river were employed to work on the hoisters; and the hoisters were required to remove such obstructions as in the opinion of these men hindered navigation. It is generally admitted by those whose business it is to run boats on the river that the stream has been much improved by the above work. Unfortunately, operations were required to cease for want of funds. The navigation of this stream will be greatly improved, and the commerce immensely increased by continuing the improvement.

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* See Chief of Engineers' Report for 1879, page 723.

† See Report of Chief of Engineers for 1880, page 845.

‡ See Report of Chief of Engineers for 1880, page 844.

§ See Report of Chief of Engineers for 1881, page 1030.

‖ See Report of Chief of Engineers for 1881, page 1029.

¶ See Report of Chief of Engineers for 1882, pages 1107 and 1108.

** See Report of Chief of Engineers for 1883, pages 866 and 867.

†† See Report of Chief of Engineers for 1884, page 1047.

‡‡ See Report of Chief of Engineers for 1885, page 1100.

§§ See Report of Chief of Engineers for 1885, pages 1100 and 1101.

The following have been the appropriations to date for this work:

1784. By State of South Carolina, £300	$1,500
1805. By State of South Carolina	4,000
1880. By the United States	7,000
1881. By the United States	6,000
1882. By the United States	6,000
1884. By the United States	8 000

The above shows that at intervals the work has been carried on for the past hundred years.

RECOMMENDATIONS FOR NEXT SEASON'S WORK.

It is respectfully recommended that work be done first in preference between the mouth of the river and Smith's Mill, by removing logs and cutting overhanging trees in the way of tug-boats and sea-going vessels. Between Smith's Mill and Dick Nalum's landing for the river steamers the same character of work is needed, and for the same purpose between the Wilmington, Columbia and Augusta Railroad Bridge and Cheraw. It is further recommended that river pilots be employed with each hoister, when possible to get them at a reasonable compensation for their services, and that only logs and snags be removed from the river at low water and the overhanging growth be cut at high water; that no attempt be made to thoroughly clear any portion of the river during the first working over by the hoisters, but that the most troublesome of the obstructions be removed first, and the others afterwards, as the hoisters will work back and forth over the whole river.

COMMERCIAL STATISTICS.

The commerce on the river during the past year has remained about the same as it was for the fiscal year ending June 30, 1885, except that the shipment of cotton increased by 4,543 bales this year, making a total of 13,400 against 8,857 bales last year. The freight has been transported by the usual number of steamers to Cheraw, and sailing vessels to Smith's Mill. There is, however, yearly quite a considerable quantity of freight carried by small boats, pole flats, or rafts, of which no account can be obtained. The traffic on this river will increase much more rapidly as soon as it is cleared of obstructions to Cheraw.

The work already accomplished seems to have benefited trade.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

Commercial statistics for improving Great Pee Dee River, South Carolina, for the fiscal year ending June 30, 1886, furnished by the steamboat agents and other reliable business men.

Articles.		Quantity.	Value.
EXPORTS.			
Cotton	bales	26,600	$1,197,000
Naval stores	barrels	53,000	477,000
Crude turpentine	do	1,500	37,500
Rough rice	bushels	78,000	97,500
Lumber	feet	1,800,000	36,000
Shingles	number	4,000,000	40,000
Ten timber	sticks	15,000	45,000
IMPORTS.			
General merchandise	tons	10,000	500,000

Total value exports and imports, $2,430,000.

The commerce has been carried on by the usual number of steamers and sailing vessels as reported last year. The removal of many troublesome obstructions by the United States Government, and the water continuing higher for a long erperiod, permitted the boats to run with more regularity than for some years past.

L 10.

IMPROVEMENT OF WACCEMAW RIVER, SOUTH CAROLINA.

The Waccemaw River, emptying into Winyaw Bay at Georgetown, S. C., has a total length of about 244 miles and a drainage area of 1,572 square miles of rich agricultural lands. This river, prior to governmental improvement in 1880, was navigable for 12-foot-draught boats at all stages of water from Georgetown, Winyaw Bay, 26 miles to Bull Creek, and at high water, 4 miles further to Buck's Lower Mills; thence for 7-foot draught boats at high water 36 miles further to Conwayboro'; thence it possessed an obstructed channel for 3-foot-draught boats at ordinary water 124 miles to Reeve's Ferry, the present head of steam navigation; thence an obstructed channel with 3-foot depth at high water for 54 miles to Lake Waccemaw, which is 244 miles distant from Georgetown. The commerce of this river is estimated to have then been about $400,000 of transported goods per year.

The original project of 1880, as continued to date, proposed for $29,000 to secure a channel 12 feet deep at all stages of water, with 80-feet bottom width, from the mouth of the river 66 miles upward to Conwayboro', and afterwards a cleared channel 178 miles further to Lake Waccemaw. This estimate was required to be made hastily, inexpensively, and during a high-water stage in the river. Its insufficiency became so evident that in 1883 $54,000 was recommended to do work originally estimated at $10,000; and later 1,000 logs, trees, and snags have been removed in a single year from a channel-bed supposed in 1880 to have been free from such obstructions. The aggregate amount appropriated for this project up to June 30, 1886, is $35,400. During the fiscal year of 1885 careful surveys were made to determine the condition of all shoals where jetties had been formerly constructed or started, and also of all shoals and sharp bends where improvement appeared specially desirable. At all places where jetties had been completed they appear to have done good, as the boats experience less trouble to-day in passing these localities, but for the want of adequate funds and other reasons half of these jetties were left unfinished, and the other half were only imperfectly and hurriedly finished. The present maps are sufficient for the construction of careful projects everywhere, and the required depth is now easily obtainable if the necessary funds be appropriated therefor. Besides this, the river was personally examined several times in 1884–'85 from Conway to Georgetown, and once in 1886 over its entire length from Lake Waccemaw to Georgetown. This latter inspection revealed the agricultural richness of the river basin, its urgent need for transportation facilities, and the worthiness of the improvement.

The present estimate (that of 1885), $138,400, for the final cost of the work is based upon these later developments.

Thirty-five thousand three hundred sixty-seven dollars and sixteen cents have been spent in all upon this improvement up to June 30, 1886, giving a thoroughly cleared channel, with 100 feet least width and 6.8 feet least depth at high water, as far as Conwayboro'. The commerce upon this portion of the river has been thereby increased to about $1,300,000 per year, showing that each dollar spent on this improvement has been accompanied by a development of about $25 of annual commerce.

The river above Reeve's Ferry is crossed by three county bridges without draws. When needed the draws will undoubtedly be put in by the county authorities.

The special work of the year is as follows: Expenditures, $3.35.

Owing to its variable features and the difficulty of properly specifying it beforehand and inspecting it afterwards, the work was allowably done by hired labor and the purchase of materials in open market.

In March, 1886, a careful and personal inspection was made of the entire river from its head in Lake Waccemaw to its mouth at Georgetown.

Other than this and office-work, and the care of the Government property, nothing was done, for the want of funds.

The general charge of the work has been under the immediate supervision of Assistant Engineer Reid Whitford. His full report, including a brief history of past work on this improvement, is herewith appended.

Recommendations for further work are as follows:

That this improvement be completed in accordance with the present approved and adopted project so far as at present to secure a channel 12 feet deep at mean low water, with 80 feet bottom width, from the mouth of the river 41 miles up to Bucksville; and thence a channel 10 feet deep at mean low water, with 80 feet bottom width, 25 miles further to Conwayboro'; thence a thoroughly cleared 3-foot navigation 124 miles farther, to Reeve's Ferry, throughout the entire year; and thence a thoroughly cleared natural channel, 54 miles further, to Lake Waccemaw; at a total expense of $103,000 in addition to the $32.84 available June 30, 1886, this amount to be appropriated in two yearly installments of $63,000 and $40,000 respectively. Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant, will increase the cost of the work by from $1,000 to $4,000 per appropriation. Further improvement, in accord with the original project so as to secure a 12-foot navigation at all stages of water from Bucksville 25 miles to Conwayboro', is not recommended at present.

After this improvement is finished its proper maintenance may cost from $1,000 to $4,000 per year.

This improvement as regards order and cost of work should be carried on approximately as follows:

Forty-five thousand dollars to secure a cleared natural channel for steam navigation from Conwayboro' 24 miles upward to Reeve's Ferry, by removing all sunken logs and snags, and by cutting down and pulling back from caving banks the trees that would otherwise soon fall into the river.

Eighteen thousand dollars to secure a 12-foot navigation at high water, from the mouth of the river 41 miles upward to Bucksville, and a similar 10-foot navigation thence 25 miles upward to Conwayboro', by dredging and jettying.

Forty thousand dollars to secure a deepened navigation at all stages of tide, and water of 12 feet depth from the mouth to Bucksville, 10 feet depth thence to Conway, and 3 feet depth to Reeve's Ferry, and to give a cleared and natural channel thence to Lake Waccemaw.

This river is in the collection district of Georgetown, S. C.

Money statement.

July 1, 1885, amount available	$36 19
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3 35
July 1, 1886, amount available	32 84
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,032 84

Amount (estimated) required for completion of existing project........	$92,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	60,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 15, 1886.

CAPTAIN: I have the honor to report as follows on the improvement of the Waccamaw River, South Carolina, to date of present fiscal year:

GENERAL FEATURES.

This river has its source in Waccemaw Lake, North Carolina, and, after flowing in a southwesterly direction approximately parallel to and not far from the sea-coast, empties its waters into Winyaw Bay, at Georgetown, S. C. The lake is a body of fresh water about 3 miles wide and 5 miles long, with probable average depth of 8 feet,* situated on the line of the Wilmington, Columbia and Augusta Railroad, about 25 miles from Wilmington, N. C. The total length of the river is possibly 244 miles, and the distance from head to mouth by a straight line would probably be 80 miles.

During low stage of the river the influence of the lunar tides is felt probably as far up as 105 miles above Georgetown, which goes to prove that even the total fall of the river must of necessity be very little.

At the flush-water periods, however, there is a constant fluvial current, for the most part though there may be a slight swell of the flood for some distance up the river.

There is no trouble about a 90-foot navigation of 8-feet depth at present to Bucksville, 40.5 miles above Georgetown at any stage of the water, and 6 feet from that place to Conway, the principal town on the river 25 miles further up.

Above Conway the depth is less, though steamers drawing from 3 to 4 feet generally run to a point at least 40 miles above that town, at possibly the lowest stages of the river.

There is very little current on the Lower Waccemaw, but a greater velocity on the upper portion of the river is found.

This stream flows through a cypress and juniper timbered land, which imparts to its waters a dark hue, but the water is said to be very pure and healthy.

The soil along the river is well adapted to the production of cotton, corn, potatoes, rice, and various fruits. The lands generally are well and richly timbered. It is thought that there is no river in this State better suited to free, safe, and easy navigation than this. The Waccemaw may at some future day form a link in the chain of the proposed "Inland Water Route" along the Atlantic coast. Capt. Charles B. Phillips refers to the possibility of this in a report of his to the Chief of Engineers, in 1880 concerning this river, and adds that this same thing was mentioned over 40 years previous to that time by Lieut. Col. James Kearney, Topographical Engineer

HISTORY OF THE IMPROVEMENT OF THE WACCEMAW.

1778.† An act of the South Carolina legislature providing for the improvement of the river from the North Carolina line to Holder's Bluff, the work to be done by the male inhabitants of the country along the river, each of whom was to serve in this way twelve days in the year.

1783.† An act of the same legislature provided for the improvement between points, and in the same manner as above mentioned.

1805.† An act of the same legislature was found which appointed a Board of Commissioners whose duty it was to ascertain, by examination, the cost of the improvement of the river from the mouth of Bull Creek to the North Carolina State line.

1879. March 3 an act was passed by the United States Congress providing for an examination of the river.

The examination was made the following November under the direction of Capt. Charles B. Phillips, Corps of Engineers, United States Army. It was estimated that the total cost of improving the river would be $29,370, and Captain Phillips recommended that this amount be expended in carrying out a project which contemplated removing obstructions, such as sunken logs, snags, overhanging trees, &c., from the river, both above and below Conway.*

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* See Annual Report of the Chief of Engineers for 1884, page 1057.

† See back acts of South Carolina legislature.

1880–'81. An act of Congress June 14, 1880, appropriated $15,000 for this work.*

H. Heth, assistant engineer, was placed in local charge of this work in the autumn of 1880. Capt. James Mercur, Corps of Engineers, United States Army, assumed control of the improvement upon the death of Captain Phillips, June 14, 1881.

In February of this year the project was modified and improved to embrace the construction of jetties and dikes at twelve points below Conway. This was done because though advertised for the usual length of time, there were no bids received for dredging, and aside from this it was thought that any extra depth gained by such means would only be temporary, unless the water-ways were contracted by jetties, and the currents over the shoals thus accelerated.†

An act of March 3, 1881, appropriated $10,000 for this work.

The work of building jetties was begun in March, 1881, at the Needles Eye Shoal, and to the end of the following June the piles had been driven on two other shoals, viz, Oat Bed and Green Landing. Some work was also done before the end of the fiscal year of 1881 towards deepening Needles Eye Shoal by the scouring action of a tug-boat's propeller screw. The boat employed for this purpose was properly moored to accomplish the same.†

1881–'82. An act of August 2 appropriated $4,400 more for the improvement. During the fiscal year of 1881–'82 jettying was done on six additional shoals, and more work was done at Needles Eye and Oat Bed shoals.‡

The river was further improved this year by the removal of sunken logs and overhanging trees.

Operations ceased for the season 31st of May, 1882.‡

1882–'83. Captain Mercur, finding the amount of the original estimate totally inadequate to complete the improvement, recommended an expenditure of $25,228 more in this direction.§

Work was resumed March 29, 1883, and owing to the small amount of the appropriation then remaining available it was determined to apply this to the removal of sunken logs, &c., from the bed of the river, and overhanging trees from its banks. This work was being carried on between Conway and Cox's Shoal at the end of the fiscal year 1883.‖

1883–'84. Captain Mercur examined the Waccamaw River between Lake Waccamaw, North Carolina, and Conway, in the year 1883.¶

Work of removing obstructions was carried on between Conway and Needles Eye Shoal during fiscal year, and 2,871 trees which overhung the channel were removed, and a few logs and snags taken out of same.**

1884–'85. Captain Mercur was relieved by Captain Hinman, Corps of Engineers, in March, 1884.

Reid Whitford, assistant engineer, was placed in local charge of the work in May, 1884, vice H. Heth, assistant engineer, resigned. An act of July 5, 1884, appropriated $6,000 more for carrying on the improvement.**

Captain Hinman was relieved by Captain Bixby, Corps of Engineers, United States Army, in August, 1884. During the fall and winter of 1884 and 1885 careful surveys were made of all the shoals and most of the proposed cut-offs below Conway, and water-gauges and bench-marks established at the same places, securing the low-water level.

These surveys were for the purpose of basing thereon reliable estimates, looking to future work connected therewith.

1884–'85. Under the existing project operations were resumed at the town of Conway on September 22, 1884, and continued till 7th of following April, when work was stopped because of exhaustion of funds. The improvement this time consisted entirely in the removal of logs and snags from the bed of the river and the trimming away of overhanging growth from the banks, all below Conway. In this way for the year 797 sunken logs, 100 stumps, 35 large trees with roots, 17 cords of small snags, 9 barrels of rosin, 3 sticks of timber, 1 large flat-boat, and 1 small schooner were removed from the channel, and 591 large trees with roots, 1,061 small trees, the branches of 112 other trees, 99 protruding stumps, and 14,550 linear feet of brush were cleared from the banks of the river where they overhung and impeded navigation.

Besides the above, 15 cords of felled trees and brush and 131 cubic yards of earth and roots were removed from Little Needles Eye Cut-off, and repairs begun at Oat Bed Shoal Jetty.

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* See Annual Report of Chief of Engineers for 1880, pages 848 and 849.

† See Annual Report of Chief of Engineers for 1881, pages 1030 and 1031.

‡ See Annual Report of Chief of Engineers for 1882, pages 1108 and 1109.

§ See Annual Report of Chief of Engineers for 1883, page 868.

‖ See Annual Report of Chief of Engineers for 1883, page 869.

¶ See Annual Report of Chief of Engineers for 1884, page 1056.

** See Annual Report of Chief of Engineers for 1884, page 1048.

The foregoing work thoroughly cleared the Waccemaw of obstructions below Conway, so far as a careful examination and diligent search indicated.*

Captain Bixby has revised the estimate for the improvement of this river, and has recommended that a further total of $103,000 be expended in this way, and that the work be extended above Conway, so as to open up the very considerable commerce on that portion of the river.*

1885–'86. There has been no work of any kind carried on since the end of the fiscal year of 1885. It will be seen from the above that work has been either actually carried on or proposed at intervals for the past 108 years.

It is generally thought wherever the jetties have been completed they have been the means of increasing the depth of water at such points.

The following appropriations have been made to date hereof:

June 14, 1880	$15,000
March 3, 1881	10,000
August 2, 1882	4,400
July 5, 1884	6,000
Total	$35,400

RECOMMENDATIONS FOR NEXT SEASON'S WORK.

It is respectfully recommended that the improvement of the river be carried above Conway, and that the logs and snags be removed from the channel during low water and the overhanging growth trimmed and cut away at high water.

It is further recommended that no attempt be made to thoroughly clear the river of obstructions at the time of the first working over, but the most troublesome and dangerous impediments to navigation be removed first and others afterwards, as the river is worked over back and forth.

It is also recommended that during the flush-water period, when work cannot be done to advantage on the Upper Waccemaw, the Little Needles Eye Cut-off be completed, Big Needles Eye Cut-off made, and such repairs to and completion of the existing jetties be prosecuted as may be deemed necessary. Owing to the difficulty of properly classifying the work upon this river it is respectfully suggested that it be done by hired labor and machinery, which method of work it is thought will be most economical and advantageous to the Government.

COMMERCIAL STATISTICS.

As far as has been ascertained there has been very little, if any, change in the commerce on this river since the date of my last annual report. It is probable that traffic has somewhat increased upon the Upper Waccemaw.

The commerce has been carried on by the usual number of sailing vessels, steamers, flat-boats, &c.

The clearing out of the Upper Waccemaw will give an isolated country an outlet, and thereby will at once increase considerably the amount of trade on the river.

Very respectfully, your obedient servant,

REID WHITFORD.

Capt. W. H. **BIXBY**,
Corps of Engineers, U. S. A.

Commercial statistics for improving Waccemaw River, South Carolina, for the fiscal year ending June 30, 1886, *furnished by Mr. J. I. Hazard, of Georgetown.*

Articles.		Quantity.	Amount.
EXPORTS.			
Lumber	feet	2,773,961	$34,674 51
Shingles	number	2,260,700	28,258 75
Timber	feet	350,000	35,000 00
Rosin	barrels	53,500	80,250 00
Spirits turpentine	do	12,250	183,750 00
Crude turpentine	do	10,160	20,320 00
Rough rice	bushels	100,000	125,000 00
Clean rice	barrels	20,241	364,838 00
Cotton	bales	5,000	225,000 00
Miscellaneous		....	25,000 00
IMPORTS.			
General merchandise	tons	5,000	175,000 00
Total value exports and imports		....	1,296,591 26

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* See Annual Report of Chief of Engineers for 1885, page 1105.

REMARKS.

The commerce has been carried on by about the same number of steamers and sailing vessels as reported last year, with the addition of an extra propeller steamer put on the river during the year.

This boat carries the United States mail, freight, and passengers, and is an entire success. There is also in course of construction a small steamer on the upper river to be used above Conway.

L II.

IMPROVEMENT OF GEORGETOWN HARBOR, SOUTH CAROLINA.

Georgetown is situated at the head of Winyaw Bay, and at the confluence of the Sampit, Great Pee Dee, and Waccemaw rivers (the latter having conjointly a drainage area of 18,040 square miles), and is the natural harbor and sea-port for all commerce passing to and from these rivers and their tributaries. Georgetown is also a railroad terminus. This harbor, prior to governmental improvement in 1880, had an excellent well-protected anchorage of at least 1 mile in length, 150 feet width, and 15 feet depth. A bar of about 2,850 feet length and with only 9 feet depth of water was the only obstacle to an otherwise good 13-foot navigation from Georgetown 13 miles to the ocean. The commerce of this harbor is estimated to have then been about $2,000,000 of transported goods per year.

The original project of 1881, as continued to date, proposed for $14,000 to secure a dredged channel of 200 feet bottom width and 12 feet low-water depth entirely through this bar. This estimate was based on the supposition that the bar was composed only of sand and mud. Inadequate appropriations delayed all work until 1884, and when actual work was commenced it was found that the sand and mud was a mere thin surface-covering to an old cypress swamp, involving the further removal of about 600 enormous stumps. The aggregate amount appropriated upon this project, up to the 30th June, 1886, is $12,000. The present estimate (that of 1885), $39,000 for the final cost of the work, is based upon these later developments.

Eleven thousand nine hundred and eighty-six dollars and four cents have been expended in all up to June 30, 1886, giving a through cut entirely across the bar with 12 feet low-water depth, and with a variable width of from 40 to 80 feet. The commerce of the harbor is now about $3,500,000 per year, showing a total increase of $1,500,000 per year above that of 1880.

The special work of the year is as follows: Expenditures, $3,552.91.

The amount appropriated up to July, 1884, was too small for economical work, but work was then commenced because improvement was so much needed that small immediate results were regarded as more valuable than larger but delayed possible results.

Under an existing contract with Mr. Cephas Gilbert, of Georgetown, work was continued from the 30th June to 13th August, 1885, when it had to stop for want of further funds. During this time 2,684 cubic yards of sand, mud, and small roots, 66 large stumps, and 1 log were removed from the channel-bed; completing a cut entirely through the bar from Sampit River to Winyaw Bay, 2,640 feet long, at least 12 feet deep everywhere at low water, and 80 feet wide over 860 feet length, 60 feet wide over 720 feet length, and 40 feet wide over the remaining 1,060 feet length.

Other than this, and office work, and the care of the Government property, nothing has been done for want of funds. This work has been carried on with great vigor and thoroughness under the immediate supervision of Assistant Engineer Reid Whitford. His full report, including a brief history of past work upon this improvement, is herewith appended.

Recommendations for future work are as follows: That the above improvement be completed in accordance with the present approved and adopted project, so as to secure a channel of 12 feet depth at mean low water, and of about 200 feet bottom width, entirely through the bar, at a total expense of $27,000 in addition to the $13.96 available 30th June, 1886; this amount to be appropriated in two yearly installments of $20,000 and $7,000, respectively. Smaller yearly appropriations involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant will increase the cost of the work by about $2,000 per appropriation. Further improvement is desirable in order to continue this channel by a similar easy, well marked, and well defined channel entirely through the upper portion of Winyaw Bay. With this object in view a survey of the entrance to Georgetown Harbor, through Winyaw Bay, South Carolina, is desirable, and is recommended as an extension of the Georgetown Harbor improvement.

The channel once thoroughly opened will probably be permanent. By this improvement ocean vessels of 12 feet draught, after once crossing the Winyaw Bay Bar, can proceed without further delay 15 miles further to their anchorage at Georgetown.

This improvement, as regards cost and order of work, should be carried on as follows:

The present channel should be first widened throughout to 60 feet width, next to 80 feet width, and so on, each successive addition to the channel width being carried through the entire length of cut. The removal of stumps must accompany or follow immediately the removal of mud and sand. Immediate improvement is so necessary that any appropriation, however small, should be immediately utilized.

Georgetown is a port of entry.

Money statement.

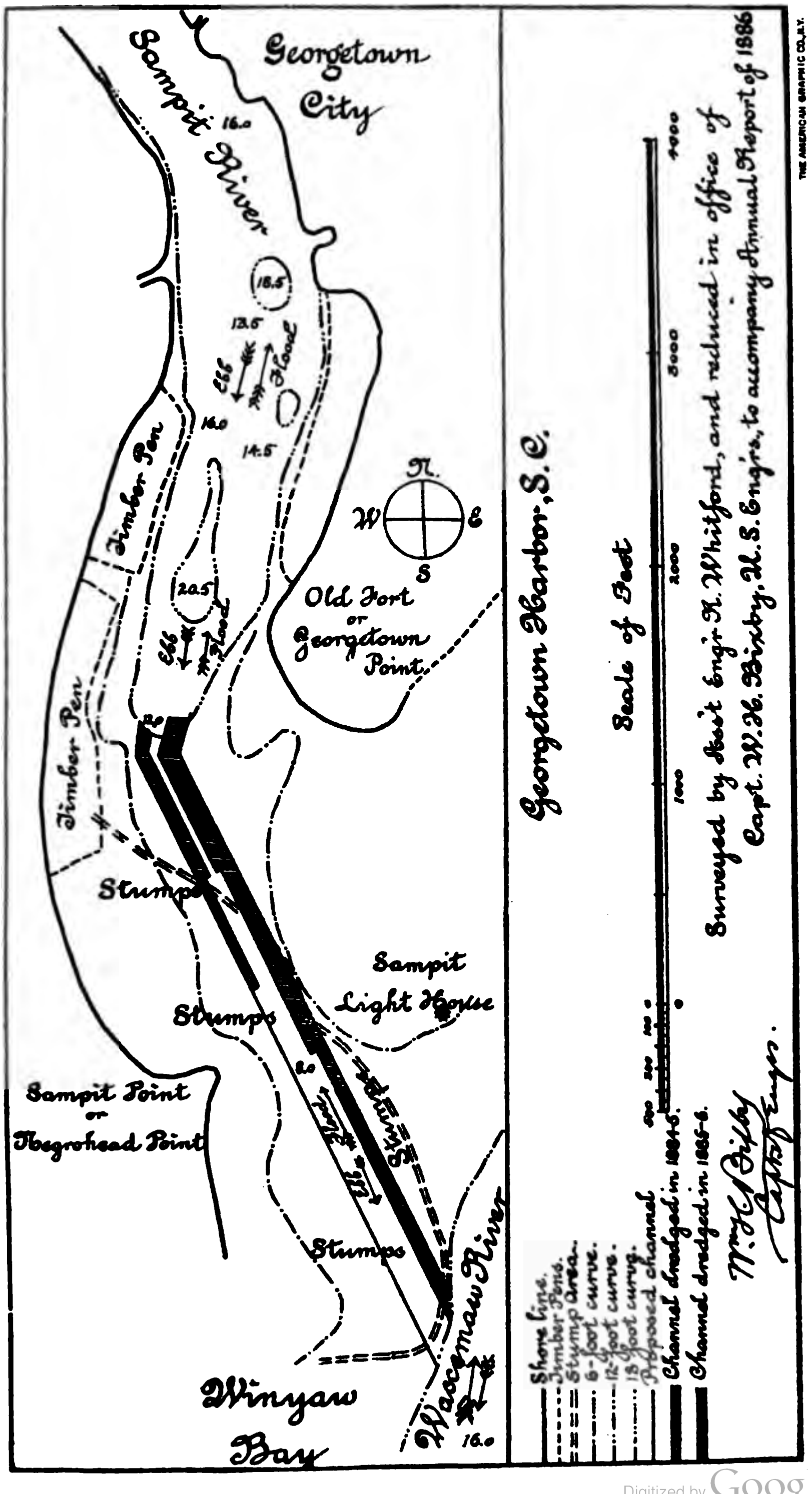
July 1, 1885, amount available		$3,566 15
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$3,550 19	
July 1, 1886, outstanding liabilities	2 00	
		3,552 19
July 1, 1886, amount available		13 96
Amount appropriated by act approved August 5, 1886		5,000 00
Amount available for fiscal year ending June 30, 1887		5.013 96

Amount (estimated) required for completion of existing project	24,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	24,000 00
Submitted in compliance with requirementsof section 2 of river and harbor acts of 1866 and 1967.	

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., February 26, 1886.

CAPTAIN: I have the honor to make the following annual report concerning the improvement of Georgetown Harbor, S. C., to date of present fiscal year.



Georgetown Harbor, S.C.

Surveyed by Ass't Eng'r R. Whitford, and reduced in office of
Capt. W. H. Bixby, U. S. Eng'rs, to accompany Annual Report of 1886

Wm. H. Bixby
Capt. Engrs.

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GENERAL FEATURES.

This harbor is situated at the head of Winyaw Bay, about 13 miles from the ocean and at Georgetown, a place of considerable commercial importance, having nearly 3,000 inhabitants. There is one railroad here on which is run daily a train to and from Lane's, a station on the northeastern railroad, giving the town very good facilities for mails and travel in any direction.

There are regular lines of large first-class schooners to New York and Baltimore, as well as lines of steamers to Charleston, S. C., and up the various rivers emptying their waters into Winyaw Bay.

The cultivation of tide-water rice is largely carried on in this vicinity, and much of it is milled and prepared for Northern markets in Georgetown.

HISTORY OF PAST IMPROVEMENT.

1879-'80. The river and harbor act of June 14, 1880, provided for a survey of Georgetown Harbor.

This work was assigned to the charge of Capt. Charles B. Phillips, Corps of Engineers, United States Army, June 17, 1880.

1880-'81. This survey was completed by Charles W. Forster, assistant engineer, between the 19th of August and 26th of September this same year.

The report that followed (for details see pages 1036 and 1037 Annual Report of the Chief of Engineers, 1881), explained the existence of a shoal about 2,850 feet in length lying across the mouth of the Sampit River and from one-half to 1 mile from Georgetown. Upon this shoal a depth of 9 feet, at ordinary low water, was reported, with the bottom consisting only of sand and sand mixed with mud. There was no mention made of the existence of stumps, and nothing of the kind was taken into consideration in forming the original estimate, amounting to a total of $14,151.94, for which there was to be removed 64,327 cubic yards of material, furnishing a depth of 12 feet at mean low water, and a width of 200 feet through the entire length of the shoal.

Captain Phillips recommended the expenditure of the above amount (see his report to the Chief of Engineers, page 1036, Annual Report Chief of Engineers for 1881). The approved project contemplated the completion of the project as stated above.

1881-'82. The river and harbor act of August 2, 1882, appropriated $7,000 for this improvement. Capt. James Mercur, Corps of Engineers, United States Army, who assumed charge of this work upon the death of Captain Phillips, June 14, 1881, recommended that operations should not be commenced (see his report to the Chief of Engineers, page 872 Annual Report Chief of Engineers for 1883) because the amount was thought to be too small to accomplish much good, and inasmuch as the construction of dikes might be necessary to prevent the dredged channel from filling.

1883-'84. The river and harbor act of July 5, 1884, appropriated $5,000 for this work, making a total of $12,000 available.

Capt. F. A. Hinman, Corps of Engineers, United States Army, who succeeded Captain Mercur in March, 1884, recommended (see his report to the Chief of Engineers page 1052, Annual Report Chief of Engineers for 1884) that the work be commenced. He also stated that dikes would probably be required, and in addition possible periodical dredging to keep the channel open.

1884-'85. Captain Hinman was succeeded by Capt. W. H. Bixby, Corps of Engineers, United States Army, in the charge of this work in August, 1884. Having been advertised for the usual length of time, in the autumn of this year the contract was awarded to Cephas Gilbert, of Georgetown, S. C., he being the lowest bidder.

Active preparations were begun by him with a dipper-dredge on the 8th of December of the same year. At the beginning large cypress stumps were encountered deeply rooted in the bottom, and upon examination the entire lower part of the shoal to be dredged was found thickly covered with stumps. This, together with very unfavorable weather, greatly retarded the progress of the work, and the stumps immensely increased the cost of the same over the original estimate. To June 30 of this year there had been dredged and removed from the shoal a total of 20,924 cubic yards of material, 3 logs, and 75 stumps of trees over 1 foot in diameter. At this time there had been completed one cut 20 feet wide and 12 feet at mean low water through the entire shoal, and several other cuts aggregating a total width of about 80 feet, and depth as given above had been finished about half way through the bar.

WORK OF PAST YEAR.

1885-'86. After June 30, 1885, dredging was continued until another cut 20 feet wide and 12 feet deep at low tide was completed through the total length of the bar, thus running the 40 feet width for a distance of 2,640 feet down to the 12-foot curve in Winyaw Bay, and thereby securing a uniform width of 40 feet through the entire bar. From this last cut there were removed 2,684 cubic yards of material, 1 log and 66 stumps of trees over 1 foot in diameter. As the dredging was extended toward Sampit Point there was found an increased number of stumps over those removed from the first cut through. It appears that this may be expected to be the case as the channel is widened. After finishing the second cut through August, 1885, on the

13th the work was suspended owing to the exhaustion of funds. Sheet A, herewith sent, shows the work done and that left to be done.

For the next season's work it is respectfully recommended that the channel be widened by working from east to west and that each cut be carried entirely through the shoal before other dredging is allowed on any other portion of the shoal. The dredged channel will thus be rendered soonest serviceable.

Captain Bixby recommended (see his report to the Chief of Engineers, in Annual Report of Chief of Engineers, pages 1114 and 1115, 1885), the continuation of the work, under the present approved project, and the further expenditure of $30,000, including the funds then available ($3,566.15).

COMMERCIAL STATISTICS.

There is no change in the general commerce of the harbor, so far as I am aware, since the date of my last annual report.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. WM. H. BIXBY,
Corps of Engineers, U. S. A.

Commercial statistics for improvement harbor at Georgetown, S. C., for the fiscal year ending June 30, 1886, furnished by Mr. J. I. Hazard, of Georgetown.

Articles.	Quantity.	Value.
EXPORTS.		
Lumber .... feet..	5,535,356	$69,191 95
Shingles .... number..	5,811,508	72,643 85
Rosin .... barrels..	143,496	215,244 00
Spirits turpentine .... do....	27,508	412,545 00
Cotton .... bales..	31,979	1,439,055 00
Rice .... barrels..	28,058	505,044 00
Tar .... do....	570	712 50
Wool .... bales..	89	8,900 00
Hides .... do....	25	1,250 00
Wax .... barrels..	6	240 00
Cross-ties .... number..	19,655	6,879 25
Crude turpentine .... barrels..	147	467 50
Furs .... cases..	1	100 00
IMPORTS.		
General merchandise .... tons..	30,000	1,025,000 00
Total value exports and imports	....	3,757,273 05

REMARKS.

The commerce has been carried on by about the same number of sailing vessels and steamers as reported last year, with the addition of one steamer, together with the arrival of and departure of several square-rigged vessels to and from foreign ports.

L 12.

IMPROVEMENT OF THE SANTEE RIVER, SOUTH CAROLINA.

The Santee River, formed by the Congaree and Wateree rivers, and emptying into the Atlantic Ocean just south of Winyaw Bay, has from the sea to its headwaters in the mountains a total length of about 500 miles, and a drainage area of 15,414 square miles. It was formerly navigated by 4-foot draught boats from the sea up to Columbia on the Congaree and Camden on the Wateree.

In 1880, the date of the commencement of governmental improvement, this navigation was considerably obstructed and blocked at all stages of water by sunken logs, snags, and floating timber. Its bar entrance was narrow, crooked, and shifting, with only about 4 feet depth of water at low tide, and so situated as to be very difficult and expensive to improve. Four steamers and a few small vessels were then running upon portions of the river. Its commerce is estimated to have then been about $600,000, and to now be about $1,400,000 of transported goods per year.

The original project of 1880 proposed for $104,000 to provide the river with a good outlet through Mosquito Creek to Winyaw Bay, by deepening and straightening this creek to 50 feet width and 7 feet depth, at an expense of $74,000; and to secure a safe and unobstructed 7-foot navigation in the river itself from its mouth 154 miles upward to Wright's Bluff; and thence a similar 5-foot navigation 30 miles further to its head in the Congaree and Wateree rivers at an expense of $30,000. This estimate was based upon a hasty and inexpensive survey, which supposed very easy and cheap dredging and no need of revetment at Mosquito Creek, and comparatively few obstructions in Santee River. Subsequent work and examinations developed numerous cypress stumps and much hard sand to be removed, and much revetment to be put in at Mosquito Creek, and showed the river obstructions estimated for were far below the number per mile actually taken out from the similar neighboring rivers. In both cases the estimates should have been more than doubled to agree with facts later developed.

The aggregate amount appropriated upon this project up to June 30, 1886, is $57,000. The present estimates, based on the later developments, are as follows:

For Mosquito Creek Canal:		
606,000 cubic yards dredging, at 33⅓ cents		$202,000
1.440 stumps, at $30 each		43,200
Drainage and dike protection against the ocean		5,600
6,000 linear feet revetment, at $3		18,000
Drawbridge (as constructed)		2,500
		271,300
For river proper:		
184 miles, at $300 per mile	$55,200	
Dredging and rock excavations	15,000	
Diking	5,000	
		75,200
		346,500

The appropriation of 1881 and since provided only for work upon the outlet of the river through Mosquito Creek to Winyaw Bay, and the approved project of 1881 for this expenditure, as continued to date, proposed to secure to the river a straightened canalized outlet through Mosquito Creek, 7 miles long, 30 feet wide, and 6 feet deep at mean low water, and to construct one draw-bridge over this creek. This work was estimated at $43,000, but being estimated on the same basis as the previous project, this amount was not half large enough. The present estimate, $144,000, based on the later developments, is as follows:

33,000 cubic yards dredging and 90 stumps (caves and deepening canal to 6 feet)	$13,700
24,000 cubic yards dredging and 90 stumps (deepening of creek)	10,700
100,000 cubic yards dredging and 20 stumps (extension of canal)	40,000
6,000 linear feet revetment, at $3	18,000
Drainage and dike protection against the ocean	5,600
	88,000
Already spent	55,346
Total	143,346

If found necessary a tide-lock must be added at a further cost of perhaps $5,000.

Fifty-five thousand three hundred and forty-six dollars and thirty-seven cents have been spent in all upon this improvement up to June 30, 1886, in removing 119,396 cubic yards of hard sand and mud, and 518 cypress stumps and logs, thereby cutting 15,610 linear feet of canal 30 feet wide and 5 feet deep, from Mosquito Creek toward Winyaw Bay; in making necessary surveys of the whole improvement, and in building a draw-bridge over the creek (in accordance with the provisions of the cession of right of way for the canal). No improvement of commerce has yet been produced, nor was any to be expected therefrom until the canal should be finally completed.

The special work of the year is as follows:

Expenditures, $14.993.62.

The amount of funds available at the commencement of the fiscal year was too small for economical work, but improvement was so much needed that small immediate actual results were regarded as more valuable than larger but delayed possible ones.

Owing to its variable features, and the difficulty of properly specifying it beforehand and inspecting it afterwards, the work was allowably done by hired labor and the purchase of materials in open market.

Between the 30th of June, 1885, and the end of November a dredge, owned by a company in Georgetown, S. C., removed 13,354 cubic yards of mud and difficult sand, three logs and 9 stumps from 1,835 linear feet of new canal, and further removed 2,073 cubic yards of caves and slides from 567 linear feet of old canal, thus opening the canal at both ends to 3 feet draught of water in Mosquito Creek.

The junctions of the canal with the creek were rounded off to facilitate the entrance of boats. Further work of dredging was stopped for want of available funds. The canal is in general 30 feet wide, and 5 feet deep at low water, but at two or three points it is narrowed by caves and slides to 18 feet clear width and 3 feet depth.

The creek entrances are at present narrow, crooked, and shallow, so that when the canal was opened in November it would allow only rafts and boats of 75 feet length, 18 feet width, 3 feet draught, to pass entirely through from Winyaw Bay to the Santee River.

Between January and June a rolling draw-bridge of 40 feet clear span and 235 feet length (including approaches), allowing the passage of wagons 10 feet wide and 13 feet high, was built at the existing roadway crossing at a cost of less than $2,500. This draw-bridge presents a fine appearance, and can be easily maneuvered by one man, and gives great satisfaction to the traveling public. This work was done by hired labor, because due advertisement failed to secure reasonable bids.

In May and June small surveys were made of the canal and adjacent river at its two ends and of the lagoons and marsh between the canal and ocean, with reference to determining the best connection between the canal and rivers and the best method of draining the lagoons and marsh. The results favor the shortening of the present located creek entrances, the closure of the present outlet of Lagoon Creek into the Government Canal, the establishment of a catch-sand fence between the lagoons and the ocean, and the drainage of the lagoons along their former drainage lines into Little Minim Creek and the Santee River. Full reasons for these minor constructions will be given prior to commencing actual work thereon.

On the 19th April, at a time of excessive high tides and heavy winds from the ocean side, a time when the ocean salt water might have terribly washed over the low beach into the Lagoons Canal, the canal was closed by an inexpensive dike—first, as a safeguard against a barely possible, though improbable, future injury to the rice interests during the present incomplete condition of the canal and the present rice-growing season, and, second, as a means of completing desirable observations as to the motion and quality of the water in the canal with reference to the merits or necessity of a future flood-gate or tide-lock in the canal.

A series of inspections and special examinations were commenced in December, 1885, while the canal was open, in order to determine whether the opening of the canal had damaged or would damage the rice interests of the neighborhood by the introduction of salt or impure water. A full report of the result of these examinations was rendered on the 25th February, 1886 (since published in House Ex. Doc. No. 114, Forty-ninth Congress, first session; copy inclosed). From the 26th March, the commencement of the rice-planting season, up to the 30th June, 1886 (the 31st of March accidentally omitted), inspections of the canal have been made daily and numerous samples of water at various points have been collected and bottled. These inspections commenced while the canal was open and continued after the canal was closed, and they have been supplemented by several special inspections, some made by a rice planter of long experience, some by the assistant engineer, some by myself, one of the latter having extended over the whole length of the canal at a moment when all conditions were most unfavorable to the pureness of the water in the canal, and on a day and even hour when special complaints were being made unknown to me at the time. In the last of May and through June heavy freshets in the Pee Dee and Santee rivers flooded the rice-fields with fresh water. All the evidence collected from these examinations and inspections and from all other reliable sources tends to show that Mosquito Creek has been no salter and no more impure since the opening of the Government Canal than it was before such opening, and they show that while the Government Canal was open (and since) some of the salt, bad, or impure water in the Government Canal has come from the rice-planters' canals and the rest of it has come from the upper tidal basins of the creek itself, and none of it has come through the Government Canal; that by reason of the canal there has been no flow of salt water into Mosquito Creek nor any injury to the rice interests; and that the preponderance of motion of water in the canal has been from the Santee River towards Winyaw Bay, this being the direction which will benefit, instead of injuring, the rice interests.

The commencement of this canal in 1881-'82 and its opening in 1885 have been bitterly opposed by Mr. R. I'on Lowndes, a rice planter of Mosquito Creek. In 1881-'82, after a delay of four months and a full investigation by the War Department, his objections were found insufficient, and work was ordered to be resumed. (See action of Secretary of War, dated 3d March, 1882, on letter of Engineer Department, with eighteen inclosures.) In December, 1885, another vigorous attempt was made to delay work by complaints that the opening of the canal had damaged the rice interests, and that the canal must be closed or furnished with a tide-lock. My full report of 25th February, 1886, showed that past damage was imaginary, and that future damage, when probable, would be prevented by simple means available to the Engineer Department, as had been previously stated to Mr. Lowndes.

Another attack was later made by Mr. R. I'on Lowndes' own petition to Congress, dated 6th February, 1886, accompanied by the petition, dated 1st February, 1886, of sixty-two other persons claiming to be interested in rice cultivation on Mosquito Creek, and repeating the complaints previously made by Mr. Lowndes. These petitions were, by my letters of 18th March and 1st of May, shown to be without reliable foundation, and, furthermore, several of the signers of the latter petition afterwards came forward and made affidavit (see my letter of 1st of May) that at the time of signing the petition they were laborers in the employ of Mr. Lowndes; that the petition was not read to them before signing; that they did not know the purport of said petition at the time of signing; that the rest of the sixty-two persons were also laborers in the employ of Mr. Lowndes; and that they had never seen any material change in the Mosquito Creek water resulting from the outflowing water through the United States Canal. Considering the voluminous official correspondence connected with Mr. Lowndes' last complaint, the insufficiency of his reasons, the damage to the commercial interests of the neighborhood by these unnecessary delays, the annoyance to the progress of the work, the expense of otherwise unnecessary inspections and examinations, the comparatively small value of the Lowndes property, rated for taxation, buildings included, at $7,940 in 1881, at the time of commencement of the canal, and the manner in which Mr. Lowndes' petitions appear by affidavit to have been obtained from men ignorant of what they were signing, I recommend that further similar complaints from Mr. R. I'on Lowndes be answered by a mere reference to past records.

During the past year the work of this improvement has been carried on with great vigor and thoroughness under the immediate supervision of Assistant Engineer Reid Whitford, whose report (including a brief history of past work upon this improvement) is appended.

Recommendations for future work are as follows:

That this improvement be completed in accordance with the present approved and adopted project of 1881, so as to secure to the Santee River a straightened canalized outlet through Mosquito Creek 7 miles long, 30 feet wide, and 6 feet deep at mean low water at a total expense of $88,000, in addition to the $1,653.63 available 30th June, 1886, this amount to be appropriated in two yearly installments of $48,000 and $40,000 respectively; also that this improvement be extended in accordance with the proposed original project of 1880, so as to secure a safe and unobstructed 7-foot navigation from the mouth of the Santee River 154 miles upward to Wright's Bluff, and thence a similar 5-foot navigation 30 miles further to its head in the Congaree and Wateree rivers at a total expense of $75,000, to be appropriated in two yearly installments of about $45,000 each. Smaller yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant, will increase the cost of the work by from $2,000 to $6,000 per appropriation. It is estimated that this last recommended improvement would at once (as already shown by past experience on the neighboring Pee Dee River) increase the Santee River commerce by from $1,000,000 to $2,000,000 per year. Further improvement, so as to increase the above widths and depths of either canal or river, is not recommended until commerce shall have shown a further immediate necessity therefor.

After this improvement is finished, its proper maintenance may cost from $3,000 to $5,000 per year.

It is desirable that two more short cut-offs should be made across long loops of Mosquito Creek, and perhaps one located cut-off be changed in position. The expense of obtaining the right of way for these cut-offs, if anything, will be slight. It is therefore recommended that such small portion of the amount appropriated for the improvement of the Santee River, South Carolina, as is deemed advisable by the Secretary of War, may be used for acquiring the right of way for the proposed project, the said right of way to be obtained by agreement with parties interested, or in the event of failure to make a reasonable agreement, by condemnation, as provided for by the laws of the State of South Carolina.

This improvement, as regards cost and order of work, should be carried on as follows:

Five thousand six hundred dollars for side-drainage and protection of the canal against the ocean, of which $4,000 for a drainage-ditch from the Lagoons into Little Minim Creek; $1,000 for a catch-sand fence to form a sand-dune at the rear of the ocean beach, and $600 for a dike across Lagoon Creek just above where it now enters the canal.

Thirteen thousand seven hundred dollars for redredging caves and slides from the existing canal and deepening it everywhere to 6 feet depth.

Ten thousand seven hundred dollars for deepening Mosquito Creek, between the canal and the Santee and the Winyaw entrances.

Forty thousand dollars for extending the canal along its located line (including four cut-offs).

Eighteen thousand dollars for revetting the side of the canal where necessary.

This river and Mosquito Creek are in the collection district of Georgetown, S. C.

Money statement.

July 1, 1885, amount available		$16,647 05
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$14,557 33	
July 1, 1886, outstanding liabilities	436 09	
		14,993 42
July 1, 1886, amount available		1,653 63
Amount appropriated by act approved August 5, 1886		18,750 00
Amount available for fiscal year ending June 30, 1887		20,403 63
Amount (estimated) required for completion of existing project		150.000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		93,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for building a rolling draw-bridge over Mosquito Creek, South Carolina, opened December 7, 1885, by Capt. W. H. Bixby, Corps of Engineers.

No.	Names and addresses.	Price.
1	H. A. Ramsay Engineering Works, Baltimore, Md.	$1,900 for the superstructure only.
2	Samuel W. Skinner, Wilmington, N. C	$4,467 for bridge, as per specifications, or $4,138 with creosoted piling in place of piling encased in cement and iron cylinders.
3	King Iron and Bridge Manufacturing Company, Cleveland, Ohio.	$5,868 for an iron draw-bridge and approaches.

Rejected; price too high. Bridge built by hired labor and purchase of materials in open market at a total cost of $2,316.12.

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., June 30, 1886.

CAPTAIN: I have the honor to make the following report upon the improvement of the Santee River to date of fiscal year now ending:

GENERAL FEATURES.

The Santee is formed by the Congaree and Wateree rivers uniting their waters, and after flowing about 184 miles in a generally southerly direction, empties its waters into the Atlantic Ocean near Winyaw Bay Bar.

The river traverses a country noted for the number of virgin forests, yielding an excellent quality of cypress and other valuable timbers, besides the soil is fertile and well adapted to the production of cotton, corn, and small grain of various kinds.

On the lower part of the river tide-water rice is cultivated by irrigation. There is probably a greater bulk of this crop annually harvested and shipped than in any other section of South Carolina.

Mosquito Creek is a very crooked tide-water stream, which connects Winyaw Bay with Santee River. The middle portion of the creek is so narrow and filled up as to be impassable for even small boats, but either end is wide and deep enough for ordinary steamboat navigation. It is said that years ago Mosquito Creek at every point was sufficiently wide and deep to allow boats of considerable size to pass through. A vessel drawing 5 feet was known to go this way from river to bay.

From long neglect and disuse the creek became filled up and narrowed to its present condition. The sea-outlet or bar at the mouth of the Santee River is very shallow, probably having only 3 feet of water at low tide. In consequence of this it is very difficult for safe and easy navigation. In every direction at the mouth mud-flats extend to quite a distance, rendering any improvement towards deepening the bar expensive and not expeditious. For these reasons no known attempt has ever been made towards improvement in this way. Therefore, on account of the natural state of things thus existing at the mouth of the river, it was thought advisable and economical to provide an outlet to the sea elsewhere for the commerce coming from the large area of country which this river drains. With this in view more than one attempt has been made to complete this route, both by way of Winyaw Bay and through Cooper River. So far as known, all efforts to improve this river have been directed in furnishing this outlet, inasmuch as this matter seemed to have been of first importance in this connection, all of which will be explained in the following notes and extracts touching upon the history of the river's improvement:

1734. "Whereas: The passage to and from Winyaw is much impeded by means of sand filling up the usual passage called the Breach; Be it therefore enacted, by the authority aforesaid. That a cut or cuts be made and kept open, at or near the head of the Barkesdale Creek to old Towns Creek, at the discretion of the commissioners hereinafter named, sufficient for a boat that draws 4 feet of water, the charge of which cut or cuts shall be bourne by the inhabitants of the parish of Prince Frederick," &c.*

1786. An act of this year was passed to form a company to cut a canal from Santee River to Cooper River, thence to Charleston.*†

1809. An act of this year was passed to establish a company to cut a canal from Sampit River into Santee River.*‡

1879-'80. An act of the United States Congress of March 3, 1879, provided for an examination of the Santee River.

The examination was made under the direction of Capt. Charles B. Phillips, Corps of Engineers, in the following November. Captain Phillips recommends that the sum of $104,427 be expended upon the improvement, which would include an outlet to Winyaw Bay via Mosquito Creek, or a route further up from Minim Creek across to Winyaw Bay.§

1881. An act of Congress of March 3 appropriated $22,000 for improving Santee River by deepening and straightening its outlet to Winyaw Bay through Mosquito Creek.‖

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* Extracts from back acts of South Carolina legislature.

† This canal was actually either partially or entirely completed, but the work proved too narrow and shallow for successful service, and hence it was abandoned. This work is fully described in one of General Q. A. Gillmore's reports, page 1148 Report of Chief of Engineers for 1881.

‡ An old canal which crosses the public road between Georgetown and South Island, 8 miles from either place, shows to have been partially excavated. It was evidently abandoned before completion, and it is not known which of the above acts refers to this particular work.

§ See Annual Report of Chief of Engineers for 1880, page 917.

‖ See Annual Report of Chief of Engineers for 1881, page 11.

Capt. James Mercur, Corps of Engineers, United States Army, assumed control of the work upon the death of Captain Phillips, June, 1881.

1882. Mosquito Creek was surveyed this year under direction of Captain Mercur, who formed a project for the work, which was approved.

The project contemplated completing the passage from Winyaw Bay to Santee River by making certain cuts and using some portions of Mosquito Creek, so that a depth of 6 feet at low tide and a width of 30 feet at same stage of water would exist at every point on the route. The project also embraced the construction of a drawbridge over Mosquito Creek.

About this time strong and presistent opposition to the work proposed arose among the rice planters on the Santee end of Mosquito Creek, headed by Mr. R. I'on Lowndes, himself a prominent planter, upon the ground that the irrigating fresh water in Mosquito Creek would be destroyed by the United States Canal projecting salt water from Winyaw Bay into said creek, thus damaging their rice crops.*

Captain Mercur therefore had full tidal observations taken in Santee and Winyaw, from the result of which he based his opinions to the effect that the planters had nothing to fear from salt water injuring them, as coming from Winyaw Bay via proposed work of United States. Upon this subject Captain Mercur made a full and convincing report.

1882. Mr. W. A. Moore, assistant engineer, was placed in local charge of the work this year. An act of August 2 appropriated $20,000 more for this work.

1882-'83. The work both for dredging and building bridge was advertised in the usual manner, but no bids were received for the former, and those for the latter were considered too high. For these reasons authority was granted for doing the work by hired labor and machinery.†

Mr. L. P. Miller, of South Island, S. C., the originator and indefatigable friend of this work, who never despaired during its darkest hours, when most opposed by the combined force of all the rice planters on or near Mosquito Creek, made up a company composed of four gentlemen residing in Georgetown, who, with him, subscribed the necessary funds, which enabled him to build a first class rotary dredge, Allen patent. This dredge was furnished by agreement to the United States to do the work of dredging. Before active operations had really begun, but after the work was ordered to be commenced, this work was countermanded at the request of the Senators from South Carolina to the Secretary of War.

The object in thus stopping the work was to give Mr. R. I'on Lowndes an opportunity to be heard for himself and others in opposing the work.

The Secretary of War, after giving Mr. Lowndes a full hearing, ordered the work to be resumed. (See indorsement of Secretary of War of date March 3, 1882.)

1883-'84. The work of dredging the first cut was commenced on Mosquito Creek, about 1.7 miles from its Santee mouth, on Miller's main canal, the 18th day of July, 1883. The dredge at once encountered large cypress stumps (and they continued for 2,200 feet) on the line of the cut, which was not expected.

Reid Whitford was placed in local charge of the work November, 1883, vice W. A. Moore, resigned. Captain Mercur was relieved of the control of the work by Captain F. A. Hinman, Corps of Engineers, United States Army, in March, 1884.

To the end of the fiscal year 1884, the following had been accomplished: Six rice-field trunks, 30 feet by 6 feet by 3 feet, were constructed of pine lumber and bedded in the irrigating ditches leading from L. P. Miller's land into the canal. The most of these were either damaged or moved from their positions, because of the canal bank caving under the weight of the deposited material. Two flat-bottom boats were built for cross-sectioning and surveying purposes. Some temporary revetment of pine piles and brush were constructed at low places in the bank to prevent the excavated stuff from running back.

A coffer-dam dike was built behind the dredge so that she might have a fixed height of still water, to save the expense of raising and lowering the crane as the tide rose and fell, and at the same time the volume of water thus held in the cut kept the banks from excessive caving. Three hundred and fifty feet of movable retaining wall was prepared and operated. This was made in 10-foot sections of 1½-inch plank, with 3 inch by 3 inch upright posts and braces. This wall was placed about 10 feet from the edge of the cut and parallel to it, to hold back the deposited material which would otherwise have run back and lessened the depth dredged. The wall was moved up and reset as fast as the dredging advanced.

The dredge cut 30 feet wide and 5 feet deep at mean low water, a total distance of 7,860 feet, and removed 58,317 cubic yards of material, 501 stumps, and 1 log.‡ An act of July, 1884, appropriated $15,000 for this work.

1884-'85. Captain Hinman was relieved by Capt. W. H. Bixby, Corps of Engineers, United States Army, in August, 1884.

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* See Annual Report of Chief of Engineers for 1882, pages 1110 and 1111.
† See Annual Report of Chief of Engineers for 1883, pages 870 and 871.
‡ See Annual Report of Chief of Engineers for 1884, pages 1050, 1051.

During the fiscal year ending June 30, 1885, the following work was done:

Five thousand nine hundred and fifteen feet more of the cut was excavated to a width of 30 feet and to a depth of 5 feet at mean low water.

The quantity of material removed therefrom amounted to 47,625 cubic yards of mud and sand; also 4 large cypress logs found buried in the soil.

Operated 6,040 feet of retaining mud-walls, and built 500 feet of new wall.

The coffer-dam dike was moved up and rebuilt nearer the dredge. Veins of hard sand were come in contact with in such amounts as to greatly retard the progress of the work.

A careful but cheap stadia survey was made of the entire length of Mosquito Creek, and also of the line of cutting.

Captain Bixby recommended that this work be completed under the existing project, namely by cutting 30 feet wide and 6 feet deep at mean low tide, and that the improvement be extended up the Santee River proper; the draw-bridge also be constructed over Mosquito Creek. He does not at present recommend any width greater than 30 feet or depth more than 6 feet at low tide be made in straightening Mosquito Creek.*

1885-'86. Work of dredging was continued under the existing project till November, 1885, when the work ceased for the want of funds.

From the end of June, 1885, to the end of November, same year, the following work was done:

The dredge cut a distance of 1,835 linear feet and removed 13,354 cubic yards of material (for the most part hard sand, which was difficult to excavate), 3 logs, and 9 stumps, found under the surface of the ground.

The foregoing work completed the cut to its intersection with Lagoon Creek, and thus water connection was made between Winyaw Bay and Santee River. After the dredge had reached this point she was turned back over the cut to remove the slides which had come in after her. The funds, however, were exhausted before the cut could be in this way cleaned out or deepened to its original depth and width, and the machine only succeeded in removing slides to the amount of 2,073 cubic yards before the work had to be stopped.

The present least available width of the cut is 18 feet and its depth 3 feet at low tide.

In December, 1885, Mr. Lowndes again brought up the question of damage to his rice lands by the salt water, which he said would flow through the United States canal from Winyaw Bay into the Santee end of Mosquito Creek, and thereby totally prevent his using the Mosquito Creek water for irrigating purposes, as he had done heretofore. Mr. Lowndes pressed his side of the question with unfaltering pertinacity.

In this connection extensive water-tests and current observations were made, and numerous surveys and maps completed, all of which, together with an exhaustive report on the same subject, was forwarded in February, 1886.

The tidal and other observations upon the whole went to prove that Mr. Lowndes's fears were groundless, and that the present necessity for a tide-lock in the United States Canal as he wished could not be at once seen.

It was admitted, however, that there was a possibility of salt water finding its way into Mosquito Creek across the South Island sea-beach into the lagoon, and afterwards through the United States Canal.

Captain Bixby recommended that if any decided indications of damage were seen coming from this direction the canal be closed by the coffer-dam dike at once.

Owing to the width of the cut, and its shallow depth at certain points, caused by slides, it could not be of much use to commerce till they were taken out, and for these reasons the closure of the canal in its present condition would place the public at less inconvenience than under other circumstances.

For the above-mentioned reasons, and also because a northeast gale was prevailing along the coast, forcing the water over South Island beach, Captain Bixby decided to close the cut, which was done in April, 1886. A second and important reason, however, for its being closed was to enable daily and exhaustive tidal observations to be made, in order that the necessity of a tide-lock might be determined.

Mosquito Creek draw-bridge, which is 235 feet length over all, with a clear roadway width of 10 feet, was commenced in February, 1886, and completed in April following the fenders or approaches built this month. The work was done by hired labor, and machinery and material purchased in open market. The draw is of the rolling pattern operated by an endless chain and windlass. The clear span is 44 feet, but 4 feet of this is taken up with fender piles, so that really the draw opening is 40 feet in the clear. The bridge is well constructed of first class material, works very satisfactorily, and was built within the amount allowed for it ($2,500). Prior to the beginning of work upon it in February considerable time was consumed in getting

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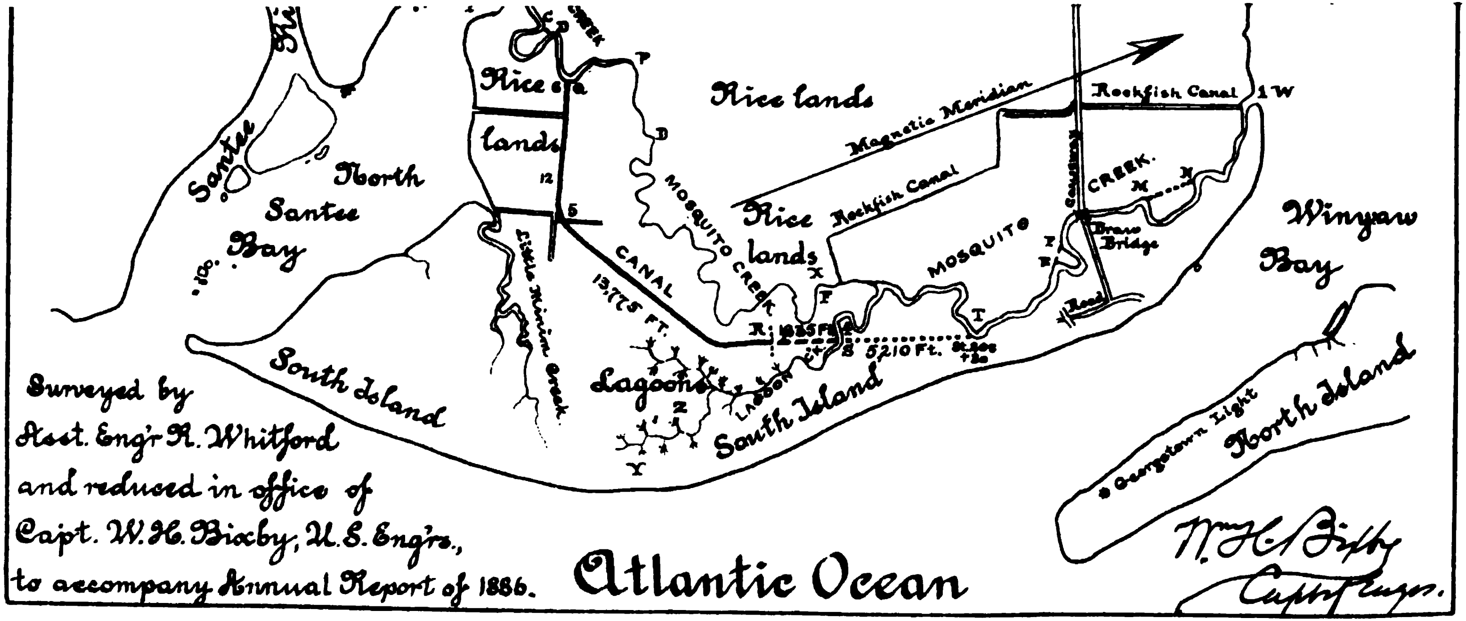
* See Annual Report of Chief of Engineers for 1885, pages 1119, 1120.



Surveyed by
Asst. Eng'r R. Whitford
and reduced in office of
Capt. W. H. Bixby, U. S. Eng'rs.,
to accompany Annual Report of 1886.

Wm H. Bixby
Capt. Engrs.

THE AMERICAN GRAPHIC CO., N.Y.

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the material for its construction on the ground. This was owing to the intense cold wave which swept over the country about then.

Since the closure of the United States Canal in April daily tidal and water tests have been made, and samples of water bottled at the dike and Santee end of Mosquito Creek.

In addition to this, tidal observations have recently been begun on the Santee side of Mr. Lowndes' lock, for the reason that Mr. Lowndes has stated that the opening of the United States Canal has not only destroyed his irrigating water but also damaged his drainage.

The observations now being made will finally settle both questions, it is hoped.

Reports have been and will be forwarded monthly in regard to these observations.

Last month the dike in canal began to leak, and after several attempts made to stop it by filling with sand-bags and mud without success, it was determined to construct a new and stronger dike and fill to the high-water line with mud. This was done during the present month. The dikes are built of parallel rows (from 6 to 8 feet apart) of sheet-piles driven across the cut and nailed to cap and mud sills. Wing-walls built in the same way extend from each corner of the dike and reach well into the canal's banks.

The first dike built was not filled in sufficiently soon after its completion, but the last was filled in immediately, and it is reasonable to suppose that it will remain tight.

Surveys have been made and levels run during the month, looking to the drainage of the surplus water from the lagoons back into the Santee River via Little Minim Creek.

The following appropriations have been made for this work:

1881. Act of Congress	$22,000
1882. Act of Congress	20,000
1884. Act of Congress	15,000
Total	57,000

From the foregoing report it will be noticed that this work has been talked of and carried on at intervals for the past one hundred and fifty-two years. It appears to have been considered an enterprise of great commercial importance and necessity, and thousands of dollars were expended years ago by private companies in their efforts to complete an outlet for the Santee River.

RECOMMENDATIONS FOR NEXT SEASON'S WORK.

It is respectfully recommended that Lagoon Creek be diked off as soon as possible, the surplus water drained from the Lagoons into Santee River via Little Minim Creek, the dikes be removed from the cut and the slides taken out, so that the cut may have its full width (30 feet) and depth (6 feet) at low water; that the cut be completed from Lagoon Creek to Mosquito Creek, and such other cut-offs be made, and such portions of the creek to be used be widened and deepened as may be deemed necessary.

After the cut is finished from Lagoon Creek to Mosquito Creek it is recommended that the other side of Lagoon Creek be diked off also. It is thought that the necessary turnout should be excavated also, and the whole line from Winyaw to Santee be prepared as far as possible for the use of the public.

It is thought that only one turnout requires excavating especially for that purpose, as the others will be furnished at convenient intervals by the sections of the creek cut off.

It is further recommended that the line of the cut M N on the Winyaw side be changed so as to make the Winyaw outlet a shorter distance from the bridge by going out at some point southeast of the present Winyaw mouth of Mosquito Creek. This would give the entrance to the canal a better protection from prevailing winds, and at the same time avoid the mud flat at the mouth of the creek.

No reason is known why the depth dredged would not remain as permanent as at the mouth of the creek. For similar reasons the cut A B on the Santee side is especially recommended to be made.

It is thought that the cuts C D and E F should also be completed.

The map herewith sent shows the cuts completed and those left to be made.

COMMERCIAL STATISTICS.

It is thought that there has been very little, if any, change in the commerce on this river from that reported last year. The usual quantity of tide-water rice was shipped, and cotton and naval stores amounted to about the same as last year. These conclusions are based upon facts furnished by the agent of the South Carolina Steamboat

Company, at Charleston; but his statement was not sufficiently complete, because no accounts of the large quantity of freight carried by boat to the Santee Bridge and shipped thence by rail could be gotten.

Mr. T. S. Martin, who has filled the position of overseer upon this work with his usual faithfulness and efficiency, deserves much praise, and I take pleasure in speaking thus of him.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

To Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

Commercial statistics for improving Santee River, South Carolina, for the fiscal year ending June 30, 1886, furnished by William P. Holmes and B. I. Hazzard, sr.

Articles.	Quantity.	Value.
EXPORTS.		
Cotton .... bales..	12,350	$555,750
Naval stores .... barrels..	25,430	228,870
Rough rice .... bushels..	150,000	202,500
IMPORTS.		
General merchandise .... tons..	9,400	470,000
Total value of exports and imports		$1,457,120

The commerce has been carried on by steamers of the South Carolina Steamboat Company's lines, together with numerous small craft, consisting of sailing vessels, pole flats, &c.

No accurate account could be gotten of the lumber, timber, shingles, crude turpentine, game, fish, furs, &c., transported over the river during the past year. It is thought that these items would considerably swell the total values of exports.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 6, 1886.

SIR: I have the honor to submit the inclosed communication from the Committee on Rivers and Harbors of the House of Representatives, dated January 27, 1886, requesting information in regard to the "improvement of the Santee River, South Carolina, by dredging and straightening its outlet to Winyaw Bay through Mosquito Creek," and its relation to the rice lands in its vicinity and supposed injury thereto, and to invite attention to the accompanying report upon the subject from Capt. W. H. Bixby, Corps of Engineers, which contains information of much interest and value, and recommend that it be transmitted to the Speaker of the House of Representatives for the information of the Committee on Rivers and Harbors.

Very respectfully, your obedient servant,

JOHN NEWTON,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

Hon. WILLIAM C. ENDICOTT,
Secretary of War.

SPECIAL REPORT OF CAPTAIN W. H. BIXBY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Wilmington, N. C., February 25, 1886.

SIR: Certain persons own rice lands upon Mosquito Creek, South Carolina, in the vicinity of the canal now being cut by the United States Government under appropriations for the improvement of the Santee River, by widening and deepening its outlet to Winyaw Bay through Mosquito Creek. These persons have lately made complaints that the opening of this canal had injured their rice interests and would injure their rice cultivation this next summer. In consequence of these complaints, I have had a careful examination made as to this claimed past injury and the possibilities of future injury. This examination was intrusted to Assistant Engineer Reid Whitford, who has had local charge of this improvement of the Santee River for the last two years. His report, full and thorough, is herewith appended, accompanied by foot-notes added by Mr. R. I'on Lowndes, who represents the rice interests, asking protection. A great many rice planters have submitted sworn opinions as to what they think will happen next summer if the canal remains open, but as these opinions are far from unanimous and are almost entirely theoretical, I have not thought it necessary to forward them. I find the only past injuries are those caused by the fears as to future injury. The danger from future injury I regard as slight.

The condition of matters at present may be stated as follows: The rice fields of Mosquito Creek border on the creek from P to X (see appended map*), and in summer must be irrigated by fresh water, obtained mainly from the creek between Q and X. During the summer Winyaw Bay is generally salt at all stages of the tide and pours salt water into Mosquito Creek via its Winyaw Bay mouth (W). During summer the Santee River is generally fresh during a portion of each tide. These two waters, from Santee River and Winyaw Bay, have been separated heretofore by a tide-gate at X, which opened automatically to allow water to pass toward Winyaw Bay, but closed automatically to prevent water from passing toward the Santee. When fresh water from the Santee River came up Mosquito Creek it was allowed to push all the impure, brackish or salt water through the tide-gate at X, and the fields from Q to X were then irrigated with this fresh water before the arrival of the next installment of salt or brackish water. If at this moment this fresh water be contaminated by salt water from any source the irrigation of the fields must be abandoned until the next tide, and if several days pass without fresh-water irrigation the rice crop will be seriously injured if not destroyed.

For several years past, at very high tides, salt water direct from the ocean has passed through the sand dunes of the beach at Y into lagoons at Z, and thence through Lagoon Creek (Z S V) and Mosquito Creek (V T W), to Winyaw Bay at W.

Last June the canal extended only from Q to R, and all salt water from the lagoons Z and from Winyaw Bay (W) backing up Mosquito Creek (V X) on the Winyaw Bay side was prevented by the tide-gate (X) from going over to the Santee side.

Now, the canal extends all the way from Q to S, and free communication is thereby opened between the Winyaw and Santee ends of Mosquito Creek. Now, salt water coming direct from the ocean over the sand dunes (Y) through the lagoons (Z) and Lagoon Creek (Z S), may go through the canal (S R Q) to the Santee end of Mosquito Creek (P Q X), and spoil the water at the moment when irrigation demands fresh water only. During the high-water season of this winter a little water has already gone that way, and some of the rice planters claim that a great deal will go that way during the low water of next summer. Moreover, the lagoons (Z) can act as a head tidal basin for water from both Winyaw Bay (W) and the Santee River (P). During the high-water season of this winter the meeting of the Santee and Winyaw waters has occurred at a point on the Winyaw side (between S and V) of the canal; the lagoons (Z) and Lagoon Creek (Z S V) have served as a tidal basin for the Santee River water only, and far as known no water from Winyaw Bay (W) has succeeded in getting up into this tidal basin (S Z); but some of the rice planters claim that next summer large quantities of salt water from Winyaw Bay (W) will flow through Mosquito Creek (W T V), Lagoon Creek (V S), and the canal (S R Q), and will spoil the water in the Santee end of Mosquito Creek (P Q X) at the very moment when irrigation demands fresh water only.

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* Omitted; printed in House Ex. Doc. No. 114, Forty-ninth Congress, first session.

The present projects for the canal contemplate extending the canal from S to T; and then the lagoon water will not be allowed to enter the canal at S, but by an inverted siphon at S, or a side drain (S T) will be drained off to T on the Winyaw side of the meeting of the Winyaw and Santee waters; so that then the only possible injury to the rice interests will be that caused by Winyaw Bay water passing through the canal to the Santee side. If this occurs it must be prevented by the use of a tide-gate in the canal between S and Q; and the original projects of my predecessor contained a proviso for such a tide-gate. A serviceable tide-gate sufficient for several years' use, if needed, could be constructed in this canal at a cost of not more than $5,000.

A careful consideration of the question as it now stands leads me to the following conclusions:

All the information so far received tends to confirm the opinion of my predecessor, Captain Mercur, to the effect that the Mosquito Creek Canal when completed will not prove in any way injurious to the rice interests of Mosquito Creek.

If the canal in its present unfinished condition is to remain open during next summer it is possible that the rice interests at the Santee end of Mosquito Creek may be injured by salt water coming directly from the ocean over the sand dunes, or coming directly from Winyaw Bay, and entering the creek at the Santee end by way of the Government canal. I do not think such injury probable, but yet it is possible. The possible loss to these rice interests in one summer is from $50,000 to $100,000.

If at any time next summer such injury should in my opinion appear probable and immediate, I should have the canal closed immediately by a temporary coffer-dam dike, constructed at once at an expense of $200 or less from materials and by means of funds which I have retained for that purpose from the existing appropriations. This closure of the canal will completely protect the rice interests of Mosquito Creek. As this closure can be made at any time upon a few days' notice, I shall not do it until actually necessary.

If such temporary closure of the canal becomes necessary, I should at once recommend the construction in the canal of a small and comparatively inexpensive tide-gate to cost not over $5,000, which gate would allow the resumption of canal traffic while protecting and even benefiting the rice interests of Mosquito Creek. This tide-gate would be automatic in its action, and would of itself remain open half of each day during summer; it may further be allowed to remain open all day during winter without injury to the rice interests of Mosquito Creek. As the possible need of such a tide-gate was foreseen and referred to in the original projects under which past appropriations were voted for this work, the cost or construction of such a tide-gate, at any future moment when its actual need should become evident, might be considered as a proper expenditure under the appropriations for the completion of the canal.

In submitting this report I request also an approval of the line of action which I have here outlined as in my opinion necessary to protect the rice interests of Mosquito Creek, while the Government canal remains in its present unfinished condition.

Very respectfully, your obedient servant,

W. H. BIXBY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. ARMY,
(Through Lieut. Col. W. P. Craighill, supervising engineer.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., March 1, 1886.

Respectfully forwarded to the Chief of Engineers. Capt. W. H. Bixby's views are approved.

WM. P. CRAIGHILL,
Lieut. Col. of Engineers.

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., February 10, 1886.

CAPTAIN: In compliance with orders contained in your letter of 17th December, 1885 (No. 7086 Sn. '85), I have the honor to submit the detailed report that follows, with reference to the present or future injury to the rice lands bordering on and near to Mosquito Creek, by salt water entering that creek through the United States canal, which has recently been connected with Lagoon Creek.

Permit me to preface these remarks by giving a brief statement of the method in general use in this vicinity of cultivating the rice lands on the irrigating system.

This information has been kindly furnished me by Mr. John A. Hume, a rice planter of long experience and a gentleman of high standing in this community. Mr. Hume's lengthy and thorough vocation as a planter of rice well fits him to be authority on this subject.

The planting season begins about the 1st of April of each year and continues at intervals until the middle of June. There are two ways of planting rice, namely, the "open trench" and the "covered." The "open trench" is most used here now. Soon as the seed is sowed in open trench it becomes necessary to flow the fields with pure fresh water to a depth of about 1 foot. This water remains on the rice from ten to twenty days, at which time it is drained off, the seed having sprouted to a height of about 2 inches. The land is kept dry for about three days to allow the rice to take firm root in the soil, and it is then flowed again with pure fresh water to protect the young rice from the ravages of the birds and also from being dried up by the sun. This is known as the sun, the point, or bird flow. At the end of three days, if this flow is used as a long point, the water level is lowered until the leaf is just visible in the depressed portions of the field. The object of the long point is to kill the growing grass and to force the rice forward. The water level remains lowered for about eighteen days, when the flooded fields are dried for some thirty days. During this period the rice is hoed twice and picked of weeds.

At the end of the thirty days' drying the lay-by or harvest flow is put on, which should, as usual, be pure, fresh water, and allowed to rise in the fields to a height corresponding with the long-point flow, and thus kept for ten days. This water is then drawn off, having become impure by stagnation, and fresh water is run back at the next flood tide to a height exceeding that of the former flow by about two inches.

The water is now exchanged weekly for a fresher supply, until the crop is ripe, and it is then dried, so that it may be cut and harvested, which is generally done during September and October. No more irrigating water is wanted until the next year's crop.

During the progress of the growing rice crop, from first to last, it is subject to the following damages or destruction:

(1) Ravages of black-birds or May-birds.

(2) In the dry growth, grub-worms eating the roots.

(3) In the water growth, maggots eating the roots.

(4) Ravages of the black and rice birds when the rice is in milk, beginning in August.

(5) Strong winds whipping off the blossoms and heads, high tides and heavy rains flooding the fields to such a depth as to cause the lower leaves of the rice to shed off.

(6) Salt gale tides will at any time totally destroy the entire crop, and they are constantly a source of uneasiness to the planter, but they are more particularly expected in autumn. When the salt tides leave the lands quickly the crop *may be* saved, but in a damaged condition. However, all cut rice lying in the fields is generally totally lost when the fields are thus swept over by storm tides:

Remedies for the above:

(1) Keep out birds as best they can.

(2) Flow one tide in and then immediately out. The water should be fresh and will kill the grubs.

(3) Dry the land for three days, thus allowing the heat of the sun to kill the maggots, after which put fresh water back. Maggots are caused by impure irrigating water. They appear at the time of the last or harvest flow when the rice is not injured by drying for three days.

(4) Keep out birds as best they can.

(5) No remedy.

(6) No remedy.

It will be seen that the cultivation of tide-water rice requires a succession of floodings from beginning to end. Therefore, taking into consideration the foregoing facts, it is reasonably concluded that rice must have for its successful production by irrigation pure, sweet fresh water. The rice planter studiously avoids the admission of brackish water into his fields, as it means serious damage to his growing crop.

In addition to the former condition of Mosquito Creek and the adjacent rice lands, I am also indebted to Mr. John A. Hume for the following information concerning the above subject. Mr. Hume has been a planter since 1839, having been born in 1822. He says that as far back as 1824 rice was planted on about 500 acres of the lands bordering on the west side of Mosquito Creek, and, as well as he remembers to have been told, even then owned by the following planters:

	Acres.
Maxwell	200
Lowndes (grandfather of R. I'on Lowndes)	200
Hume (father of John A. Hume)	100

There was no bridge across Mosquito Creek at this early day. The creek was open from Winyaw Bay to Santee Bay for the passage of flat-boats 50 feet long, 12 feet wide, and 3 feet deep. The first crop of rice ever planted by Mr. Maxwell on Mosquito Creek was entirely destroyed by the great storm of 1822. Mr. Hume gathers all the above from conversations held with his father. What follows he states as coming within reach of his own recollection. The first bridge across Mosquito Creek was built in the year 1836. At this date all the rice lands on Mosquito were cultivated except about 200 acres, prepared since by Mr. Richard H. Lowndes, father of Mr. R. I'on Lowndes, and the Ford land, now owned by Col. L. H. Miller. For a number of years after this time, Mr. Hume has known flats as above mentioned to go through Mosquito Creek from bay to bay. He was a resident of South Island for about thirty years, beginning in 1839, and that previous to this year he often visited his father's plantation on Mosquito Creek, and which he himself afterwards planted with continuous success.

In early days the planters feared the damage from salt water from the ocean sweeping across the beach and the low-lying marsh lands upon their rice fields during gale-tides, and that as far back as forty years ago Mr. Hume, in company with Mr. Rollins Lowndes (uncle of the present Mr. R. I'on Lowndes), Mr. F. W. Johnstone (uncle of the present Mr. William C. Johnstone), Mr. F. W. Ford (father of the present Mr. Morris Ford), and Mr. Elias Doar (father of the present Mr. T. W. Doar), all prominent and wealthy planters, visited a point on Lagoon Creek near the place where the line of the United States Canal now crosses that stream, with a view of maturing plans to dike off, by their own private means, the overflowing sea-water; but for some reason, not now remembered, this proposed scheme was not carried out. The years 1844 and 1845, especially 1844, were known to the old-time planters on Mosquito Creek as salt years, because all their irrigating water became salt and so remained for the entire rice season. This was due to an unusual drought of long duration in the up country and the consequent extreme low water in the rivers. Mr. Hume was then planting on Mosquito Creek, and he states that his land in the year 1844 only produced 3,000 bushels of damaged rice, when generally the harvest amounted to about 15,000 bushels of an excellent quality. He did not even attempt to use the water from Mosquito Creek, that being entirely too salt at all times to risk in flooding the rice, but that he drew his supply of water from China Creek, a stream some distance above Mosquito and not often subject to salt tides, but even that source was sufficiently brackish to almost entirely destroy his crop. As well as he remembers, the salt extended as high up the Santee as the upper mouth of Minim Creek.

I respectfully inclose copies of affidavits (Nos. 5, 6, 7, and 8) of Messrs. Simons Lucas, G. G. Ford, E. G. Hume, and E. M. Lucas, relating to the foregoing subject—viz., the former condition of Mosquito Creek, &c.—gentlemen well and favorably known in this section of the State. These copies were furnished by Mr. L. P. Miller, the originals of which were forwarded to the United States Engineer at Norfolk several years ago.

The United States Canal was begun on the 17th of July, 1883, at a point on Mosquito Creek about 1.70 miles above its Santee mouth, and was completed on lines as shown on sheet F to Lagoon Creek the 1st of November, 1885. The cut was executed to a width of 30 feet and to a depth of 5 to 6 feet at mean low water, but these dimensions have since changed at several points by caving banks and slides to a least width of about 18 feet and to a least depth of 3 feet at mean low water. The distance from Santee River to Lagoon Creek, via Mosquito Creek and the canal, is 4.68 miles. During the autumn of 1883, and the winter, spring, with a portion of the summer of 1884, tests were made by Mr. W. L. Miller, United States rodman, and Mr. Thomas S. Martin, United States overseer, to discover the existence of salt water in the cut behind the dredge at high and low tides. Copies of the results* of these tests are respectfully sent herewith. Mr. Miller's observations were taken between the initial point of the cut and station 20 (stations 100 feet apart), and shows the water to have been salt at fourteen low waters between the dates of October 5, 1883, and January 3, 1884, inclusive, covering the same period the water was salt for fifteen high waters.

Mr. Martin's observations were taken between the initial point and station 70, and shows only one salt tide, which occurred February 20, 1884. The following facts are extracted from the official records of the Santee work of dredging as kept by Overseer Martin:

An easterly gale prevailed along this coast in September, 1884 (10th, 11th, 12th, and 13th), forcing the salt water over the marsh lands bordering on Mosquito Creek and Lagoon Creek to a depth of about 2 feet, the vertical rise of the tide being about 5 feet above mean low water.

The United States Canal had at that time reached a distance of 9,070 feet from its beginning. The depth of this overflow was sufficient to cause the dredge to suspend operations for ten days because of the difficulty experienced by the laborers in cutting and trimming the sides of the cut ahead of the dredge with their saws and spades. On the 11th of October, 1885, the marsh lands were again flooded by an easterly gale with salt water coming across the beach from the sea, and on this occasion the vertical rise of the tide was 6 feet above mean low water covering the marsh lands to a depth of 3 feet. The dredge had reached a point within 500 feet of Lagoon Creek and 15,150 feet from its beginning. This surplus water was rapidly carried off by the United States Canal, permitting the dredge to resume excavating after a stoppage of four days. So great was the force of the water being driven across the sea beach by the accompanying strong wind against the United States Canal bank that about 40 feet in length of the bank gave away and was swept into the cut. The bank at this place was composed of sand and mud, having a bottom width of about 60 feet, a least top width of about 10 feet, with its crest reaching to a height of about 8 feet above the mean low-water level in the canal. Subsequent to this gale the water in the canal was salt until its junction with Lagoon Creek, which was accomplished on November 7, 1885[1]. A copy of Mr. Martin's official report to me in regard to this matter is respectfully inclosed.

From all I can learn from parties who are best calculated to know whereof they speak, it has always been an established fact that the Santee end of Mosquito Creek was more or less salt for several days in succession, on the ebb tides, after every easterly blow.[2]

If no portion of the United States Canal had been in existence at the times of the gales, in September, 1884, and October, 1885, the ebb tides in the Santee end of Mosquito Creek would doubtless have been salt or brackish for some considerable time after the cessation of the blows, for no little quantities of the salt sea water would have gradually worked its way on every tide toward the Santee River and Mosquito Creek, over the low banks and through the drainage ditches along the adjacent neglected rice fields.[3]

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* Omitted.

Certainly the United States Canal drained the flooded marsh lands more rapidly and effectually than it otherwise would have been done.

When this salt water was discovered as being in the Santee end of Mosquito Creek, after the gale tides, I believe it was the custom of those whose lands were supplied with flood-gates to waste this impure water through them, on the flood, into some natural stream or canal, whenever possible, and prevent this waste water from returning on the ebb, by closing the gate on the proper side.

It has generally been understood that when there was a freshet in the Santee River, that end on Mosquito Creek was fresh at all stages of the tide, and when there was no freshet in the river the creek was fresh during the first of the flood, and afterwards became salt as the water came in from the sea.

It is said that the Santee is fresh on the last of every ebb tide, at any stage of the water in the river, and as the salt flood runs in, a portion of this fresh ebb is forced up the creek in advance of the flood, which gives the planters along the creek a sufficient use of the fresh water to flow their fields before the arrival of the following salt.[4] This is called "pocketing the fresh water."

Winyaw Bay is sometimes fresh in the wet season, when there are freshets in the rivers emptying therein, at all stages of the tide at the mouth of Mosquito Creek, but generally it is salt there at high water. During the freshet season, however, it is always fresh here on the last of the ebb. It is salt there at all stages of the tide in very dry seasons.

When the bay is fresh at all stages of the tide the Winyaw end of the creek is correspondingly fresh. When the bay is fresh on the last of the ebb no reason is known why this system of "pocketing the fresh water" would not work the same on this end of the creek as it does on the Santee end,[5] which would tend to freshen at least the upper portion of the Winyaw end of Mosquito Creek. When the bay is salt at all stages of the tide then the creek is salt correspondingly. However, it is thought that the Winyaw end of Mosquito Creek is generally spoken of as salt and the Santee end as fresh. Now, whether the upper portion of the Winyaw end of Mosquito Creek gets the most of its salt from the sea across the beach, thence through the lagoons into Lagoon Creek, is a question which will be touched upon hereafter.

I will here remark that I was told by Mr. John A. Hume that the rice lands along Mosquito Creek contain a certain percentage of aluminum, and that on this account these lands require more frequent flooding with fresh water, because the aluminum very soon has a damaging effect upon the stagnant water resting upon the lands. He also says that the rice lands further removed from the coast do not contain this injurious agent.

I have been unable to collect any data showing when or where the rice interest was ever damaged by salt water going from Winyaw Bay into the Santee end of Mosquito Creek, when the creek was open from bay to bay, nor have I ever heard that the old-time planters feared any danger from this direction.

The foregoing is about all the information I have been able to collect regarding the former condition of the Mosquito Creek or the rice lands in connection therewith.

CONCERNING THE PRESENT CONDITION OF MOSQUITO CREEK, THE UNITED STATES CANAL, THE SEA BEACH, THE OBSERVATIONS JUST COMPLETED BY THE UNDERSIGNED, ETC.

In obedience to your orders, I proceeded to the United States Canal on December 22, 1885, where I met Mr. R. I'on Lowndes by appointment. In going thither I took a boat at point marked No. 2 (see sheet F), where the water was found brackish with the tide flood. This state of the water so continued until arriving at a point in Lagoon Creek, about 300 feet below the mouth of the United States Canal, the water here changing from brackish to fresh, the fresh flood from the Santee River having reached this point. At this time the water in the United States Canal was perfectly fresh. When this same tide had fallen about 0.5 foot at the mouth of the said canal, the water therein, which was running out towards the Santee River, became brackish. This brackish water started down the cut at 11.40 a. m., and at 4.25 p. m., it had reached station 12 (stations 100 feet apart and numbered from the Santee end of the United States Canal continuously), having traveled a distance of 14,430 feet in four and three-quarter hours. The wind was very light from the south. From about the first curve on the line of the United States Canal, or point marked 5 on sheet F, the said canal feels more perceptibly the attractive influence of the falling water in Mosquito Creek, and hence empties itself much more rapidly from this point. On this same tide the water was found to be brackish in the Santee mouth of said canal at 5.20 p. m., with the ebb current still running, but tide rising vertically on the gauge.[6]

At 5.30 the fresh flood was met coming up Mosquito Creek from the Santee River, about 1,000 feet below the mouth of the United States Canal, and at the time and place of meeting with the fresh flood the tide had risen vertically 1 foot. Returning immediately into the United States Canal above its mouth, the gauge read 0.9 foot, with the ebb current still running out. This was only a few minutes after 5.30 p. m., and subsequently very little, if any, more brackish water was discharged into Mosquito Creek on that tide by the United States Canal.

It will be readily seen that the amount of water damaging to the cultivation of rice, which the United States Canal carried into Mosquito Creek on this ebb tide, amounted to very little.[7] The next day, December 22, ebb tide was of the same character of brackish water, and on this occasion it reached as far down Mosquito Creek as China Creek Canal (B on map), when the fresh water flood was met coming up the creek. I returned to the mouth of the United States Canal and waited there for the fresh flood. When it came up we allowed it to drift the boat up Mosquito Creek, past the mouth of said canal, with the tide and water a little brackish,[8] and we continued along ahead of the fresh, until we arrived at a point on Mosquito Creek marked P on sheet F, where we left the boat at 9 p. m.

This brackish water doubtless was a part of that which came out of the Government cut on the last of the ebb. It must be borne in mind also that a considerable portion of the above water is carried back up the United States Canal at the flood tides. Now, it is perfectly evident that whenever there is brackish water at the source from which the foregoing came, it will be carried down the United States Canal at every ebb tide, in quantities *more or less large*,[9] depending upon the direction of the wind mainly, and the volume of fresh water in the Santee.

When the winds prevail with strength from the west for several days in succession, depressing the low-water levels in the adjacent streams and bays, then if there should be any brackish water subject to be carried into Mosquito Creek by the United States Canal from Lagoon Creek, it may reach a point below where I have fairly observed it to have met the incoming fresh water flood, but just exactly what this excess of distance would be I am unable to say without first having observed the currents, especially upon a tide when all the conditions suited.

This may be considered an exceptional case, however, but it *might occur* at the very time of the rice-culture season.

It is not to be understood that the United States Canal carries brackish water into Mosquito Creek on every tide, for it has been observed to the contrary, viz: Thomas S. Martin, current observer, reports to me officially that on January 19, 1886, no brackish water went through the United States Canal from Lagoon Creek. He (Martin) was at mouth of canal all day, taking velocities of currents and testing water. January 21, water fresh in United States Canal and Santee end of Mosquito Creek at both ebb and flood tides. January 27, water fresh in United States Canal at all stages of the tide. Martin followed last of ebb down the canal to Mosquito Creek and found water fresh. He then went with first of flood up Mosquito Creek to point D, on sheet F, and found the water fresh all the way.

Mr. E. D. Martin, gauge observer, reports to me officially that on February 4, 1886, he found the gauge in the United States Canal at 300 feet above 6 (see sheet F) to read 0.6 (zero = mean low water) and the water fresh.

Having proven that brackish water did find its way at intervals through the United States Canal into Mosquito Creek, it next became necessary to ascertain from whence this impure water had its source. With this in view many current and tidal observations were taken at the junction of the United States Canal with Lagoon Creek, at several tides, both ebb and flood. This was accomplished with a log and line floats and by watching the flow of water with the eye. Mr. Thomas S. Martin, who has had experience in the United States Coast Survey, as gauge observer, on the coasts of South Carolina, North Carolina, and Maine, from March, 1877, to May, 1880, and who has had considerable experience in observing the flow of the currents at various places by using the log and line, was employed to observe the currents at the above place under my direction. The results of Mr. Martin's observations are respectfully forwarded herewith, as shown on sheets *A, B. C, D, and a copy of his explanatory report accompanying these sheets. As a check on these results Mr. E. D. Martin was sent to observe the currents at the same place, which he found upon the whole to agree with the above. I went there myself afterwards to do the same work, as a check to both statements, and to satisfy myself that there was no error. My own results showed no difference in what had already been made known. I was plainly convinced that the flood tides from Santee River and Winyaw Bay meet practically anywhere from about 300 feet below the point of junction of the canal with Lagoon Creek and a point in that creek about three-quarters of a mile farther down. This point varies according to the direction and strength of the prevailing winds and the volume of freshet water in Santee Bay.

At the beginning of the flood tide, which pours through the United States Canal into Lagoon Creek, the current there turns to the right and runs up Lagoon Creek into the lagoons. This current is soon joined by that of the flood from Winyaw Bay, at the mouth of the canal, and they together continue flowing up Lagoon Creek, and thence into the lagoons, for two or three hours, more or less, after which the Santee flood divides at the mouth of the canal, one portion of it continuing on up Lagoon Creek, and the other down Lagoon Creek, forcing back the Winyaw Bay water to distances as above stated. This flood into the upper portion of Lagoon Creek and the logoons reaches approximately 4,500 feet from the mouth of the canal. Upon the ebb tide the water returns from the lagoons, and for from one to two hours the flow is only observed going down the canal. After it has thus run for the above time the currents divide at the mouth of the canal, one portion continuing down the canal towards Santee River, and the other portion down Lagoon Creek below the mouth of the canal, towards Winyaw Bay. During the period when the ebb is running only down the canal there is no perceptible current in any direction in Lagoon Creek below the mouth of the canal. There is also inclosed a copy* of Mr. Martin's detailed report to me of the currents and gauge observations taken on time. The reasons for this rather peculiar movement of the water is thought to be, that owing to the near proximity of the lagoons (see sheet E,* which will give you a very good idea of their location and dimensions with the depressed level of the water in the same, that having been drawn off by the preceding ebb tide), the flood-tide current is irresistibly attracted into them till they are sufficiently replenished with water to cover their very considerable areas, and raise their levels to an elevation nearly equal to that of the water at the mouth of the United States Canal. When this has been accomplished, and needing no further the extra supply of water, the current then separates at the mouth of the canal, and only enough continues to run up to retain this secured elevation, while the excess of water emptied from the canal turns down the creek, and attacks and forces back the weaker current coming up from towards Winyaw Bay. Now, when the time arrives for the Santee to take back its water from the canal and that which has gone up into the lagoons, the current begins to return from these places, and as the water is hurried down Lagoon Creek into the canal it turns on a curve into the canal, and it is thought that the centrifugal force[10] of the water running on the outer rim of the curve is sufficient to hold back the water there at rest, preventing it from following the outgoing ebb into the canal till the time of the ebb to Winyaw Bay, when the currents gradually fork, which causes that water resting below the mouth of the canal to be carried towards Winyaw Bay and the other prong of the fork continues through the canal until the next flood. This is repeated on every tide that we observed. It will be seen that that portion of the water which deflects to the left from the mouth of the canal on the flood *does not* return down the canal on the next ebb, but flows down Lagoon Creek into Mosquito Creek towards Winyah Bay, which, of course, has a tendency to freshen Mosquito Creek to quite a degree.

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* Omitted.

Having established the facts—

(1) Winyaw Bay was fresh at low tide when the foregoing observations were made on January 8 last (and the "pocketing the fresh water system" was working on the Winyah end of Mosquito Creek, because the water was found to be fresh at Mosquito Creek Bridge when the gauge there read 3 feet), and inasmuch as on that day brackish water went down the canal towards Santee, from the above alone it was evident that the brackish water did not come from Winyaw Bay on that day.[11]

(2) That the *entire* ebb through the canal comes from the upper portion of Lagoon Creek and the connecting lagoons.

(3) That the flood tide came up from the Santee River fresh and returned in that direction sometimes brackish.

It now becomes desirable to trace the origin of this brackish water. So to this end an examination was made of the lagoons and the sea-beach near by. A line of levels was carefully run along the high-water crest of the said beach, starting from our bench-mark, securing the mean low-water level at the South Island Wharf, and then cross-sections were taken from the extreme low-water line along the sea-beach, showing the slope of the lands from the high-water crest into the lagoons. All this will be seen by reference to sheet E.*

The high-water crest was found to be elevated from 5.7 to 6.9 feet above our established mean low-water level. The mean rise of the tide is 4 feet. By allowing from 1 to 2 feet rise above this, according to the direction and strength of the wind, for the height of the inrolling billows, it is conclusive evidence that the sea salt water will run over the beach into the lagoons during flush high waters in quantities sufficiently large to cause the lagoon water to be decidedly brackish.

This, then, is the true source of the brackish water carried into Mosquito Creek by the United States Canal, and it does not come from Winyaw Bay, as has been thought.[12] If there was no Winyaw Bay in existence the state of the case would not be changed.

It is not impossible that there should be days in succession during a period of westerly winds and neap tides when no water from the sea would find its way across the beach. In this case the daily influx of fresh water from Santee would constantly freshen the lagoons, and at such times no brackish water would go down the canal. Then, on the other hand, the reverse of this might be the case. However, the amount of brackish water that goes down the canal at any time depends entirely upon the quantity of salt water which crosses the beach into the lagoons.[13]

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*Omitted.

Take a time in the dry season when, as is stated, the waters are salt or inclined so to be. This would make no difference so far as the connection of the canal with Winyaw Bay is concerned, except that the little portion of the flood from below the mouth of the canal, which goes with the Santee water into the lagoons, might add just a little to the saltishness of the lagoons.

Neither would a dry season increase the overflowing quantity of the water from the sea. It is true that the brackish water carried down the canal into Mosquito Creek on the last of the ebb, if in sufficiently large quantities, would somewhat interfere with the "pocket system" in Mosquito Creek when that creek became salt at the half-flood tide[14] from the Santee salt water.

I am told that sometimes the Santee River is fresh the entire year, and then there is no necessity for pocketing the fresh water at low tide in Mosquito Creek, but when the Santee is salt at high water and fresh at low water, the pocket system is the only means the planter on the upper part of Mosquito Creek has of securing a fresh supply of water.

Mr. W. C. Johnstone, who has long resided in this vicinity, tells me that he remembers when the sea-beach alluded to was covered by a range of hills, and that on these sand-hills there was a growth of grass, and at intervals there grew trees and brush. Then only the highest gale tides found their way across the beach. These have all been gradually destroyed by winds and storm-tides.

Mr. W. A. Moore, assistant engineer, says, in a report to Capt. James Mercur, February 1, 1882:

"On the 25th of December (1881, I suppose) I walked down the South Island Beach, and from the first hummock as far as the eye could see the tide was pouring over the beach, not continuously, but at intervals of about 200 or 300 feet. The tide in Winyaw Bay rose 4.2 feet above the plane of reference. As Lagoon Creek here is only about a quarter of a mile from the beach, I presume it will be the natural drain for this overflow. The marsh here at this time had about 3 inches of water on it. The soil between the beach and Lagoon Creek has a large percentage of sand in it and is covered by a growth of wire grass. I am told when dried it will burn, being of a peaty nature."

Mr. L. P. Miller has told me that he has frequently seen the water crossing this beach within the last few years.

I have heard Mr. Thomas S. Martin, ex-overseer of the Santee River improvement, who traveled along the beach daily for more than a year in going to his work at the dredge, say that on one occasion he found the water running so rapidly at a point across the beach that he hesitated about risking to ride his horse through it.

The writer, too, has seen the water crossing the same beach within the last two years, and he has watched with some concern the wasting away of the protecting sands, especially since the breakage in the United States Canal bank during the storm in October last.

It was his intention to offer for your consideration, as soon as more funds were available for the work, a recommendation looking to the construction of some simple "sand-catchers" along this beach, to attempt to restore, in a measure at least, the once existing sand-dunes.

SIMULTANEOUS TIDAL AND CURRENT OBSERVATIONS—THE RICE LAND SUPPOSED TO BE IN JEOPARDY—THE TIDE-LOCK, ETC.

On January 19, 1886, simultaneous readings were taken with gauges set alike on the established mean low-water lever of the Santee River, which is the same leval used in dredging the United States Canal, at the lagoon mouth of the canal, and in Mosquito Creek at station 208+30. The height of the water was generally greater at Lagoon Creek than at Mosquito Creek, as will be seen by the tabulated statement of the record which is forwarded herewith. The constancy of this greater height and the peculiar shapes of the tide-curves for this day are probably due to the strong easterly wind prevailing that day.

On February 7 simultaneous tidal and current observations were taken at the following places, with the zeros of the gauges all set on the above established mean low-water level (having previously had bench-marks fixed in the neighborhood of these places, the gauges were therefore thus set with the level, without much time or trouble). About 300 feet above the Santee mouth of Mosquito Creek, in the creek at A, see sheet F for location and sheet G* for cross-section, current velocity, and tidal observations. Three hundred feet above 6 Santee mouth of the United States Canal, in Mosquito Creek, see sheet F for location and sheet G* for other information. Three hundred feet above 6, in United States Canal, see sheets F and G.* At D, see sheet F for location; at 300 feet above 6 in United States Canal, see sheets F and G*; at 300 feet above lagoon mouth of United States Canal in Lagoon Creek, see same sheets; at about 500 feet above Winyaw mouth of Mosquito Creek, in the Creek No. 1, and about 300 feet above Winyaw mouth of Rockfish Canal, see sheets F and G.*

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* Omitted.

I would here state that though the cross-section represents Rockfish Canal to be about 80 feet wide, it narrows very soon to 20 feet, and finally becomes a mere ditch before it reaches Mosquito Creek again, near Lowndes' lock, station F. No observer could be employed for station H, and that one who should have observed at F (Lowndes' lock) failed to get on his station, and hence there are no notes for these two. I would state here, however, that on December 22 I visited Lowndes' lock at low tide and found the height of the water on the Santee side about 1 foot lower than on the Winyaw side,[15] and that on the 8th of February, 1886, Mr. Edwin D. Martin, gauge observer, was sent there to determine the difference of the water-level on the flood, which he reported to be 0.5 feet higher on Santee than on Winyah side. Martin met Mr. Lowndes there, who gave him the pencil note to hand me, concerning this difference of level at the lock, which I respectfully forward to you, as Mr. Lowndes requested.[16]

To return to the simultaneous observations taken on the 7th of February. On this day the water rose to a vertical height of 3.3 feet on the gauge at the Santee mouth of Mosquito Creek, and fell to 0.1, making the range 3.2 feet. At the Winyaw mouth of Mosquito Creek the rise was 3.4 and the fall 0.4 below zero, making the range 3.8 feet. The water therefore rose 0.1 foot higher at Winyaw Bay than at Santee River, and the water fell 0.5 foot lower at Winyaw Bay than at Santee River.[17]

High water occurred one hour earlier at Santee River than at Winyah Bay, and low water took place at the same time at both places. The flood current on the Santee side ran up 1.5 hours after high water, and the same current on the Winyah side ran up one hour after high water. The ebb current ran out on the Santee side 1.25 hours after low water, and at Winyaw Bay 1.50 hours after low water. The tide rose 0.6 foot higher at Santee River than it did at the Lagoon mouth of the United States Canal, and fell 0.9 foot lower at the Santee side, the range at Lagoon Creek being 1.7.

The turning of the flood and ebb currents occur on an average two hours earlier at the Santee River than at the Lagoon mouth of the United States Canal. The change of tides, as measured by their rise and fall, occurs 2.25 hours earlier at the Santee, or high water on the gauge at the Santee occurs three hours sooner than at Lagoon Creek, and low water at the Santee 2.50 hours sooner than at Lagoon Creek.

It will be noticeable that the existence of no salt or brackish water (see sheet C),* was found on this day, except as reported at the Lagoon mouth of the United States Canal, which no doubt flowed down the canal for some little distance, but met the incoming flood from the Santee River before it had reached Mosquito Creek, and was carried back into the lagoons.

I was told by Mr. Lowndes that there was a freshet in the Santee River on this day, but inasmuch as there was no brackish water found at the gauge at the Winyah end of Mosquito Creek during the entire rise and fall of the tides, it is but fair to assume that there was a freshet in Winyaw Bay also.

The following distances are taken from our own measurement of the United States Canal. One from Mosquito Creek across Lagoon Creek to Mosquito Creek again, at sta. 208+30 (see sheet F), made with steel tape-line, and which is known to be correct. The other distances are taken from our own stadia survey of Mosquito and Lagoon creeks, together with the two cuts on the Winyaw Bay side, which I think is about correct:

	Feet.
Total distance from Santee River to Winyaw Bay, via Mosquito Creek to the United States Canal, thence with the canal to Lagoon Creek, thence with Lagoon Creek to Mosquito, thence with Mosquito to Winyaw Bay	62,930
Distance from the Santee mouth of Mosquito Creek to mouth of United States Canal	9,570
Distance by United States Canal from Mosquito to Lagoon Creek	15,630
Distance via Lagoon and Mosquito creeks from the Lagoon mouth of the United States Canal to Winyaw Bay	37,730
Distance by the proposed line of canal from Lagoon Creek to Mosquito Creek, to sta. 208+30 (see sheet F)	5,200
Distance from Santee River to Winyaw Bay via the canal finished to sta. 208+30	49,425
Distance from sta. 208+30 to Winyaw Bay via Mosquito Creek	24,225
Distance from Santee River to Winyaw Bay via the canal finished to sta. 208+30 thence the two cuts towards Winyaw Bay completed	46,560

I would here remark that the averaged current velocities given in feet per second embraces the slackening of the flow of the water caused by the leveling of the tidal wave; that is, the actual running time of the currents is taken into consideration, and not simply the vertical rise and fall of the water.

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* Omitted.

As one-half of the flood current from the Santee River, which turns to the right after leaving the canal, penetrates the upper portion of Lagoon Creek to a distance of 3,000 feet, as it does more or less, it is then thought reasonable to suppose that if no portion of this water was allowed to flow to the right, as is recommended in the writer's annual report for Santee River improvement, dated June 30, 1885, viz., the diking off of Lagoon Creek to be included in the work of revetment, the entire volume of the flood would penetrate to a distance of about 6,000 feet down Lagoon before it met the flood from Winyaw Bay.

From current and tidal observations just taken it would appear that before this Winyaw Bay water, assuming that it would follow the Santee ebb back, could reach Mosquito Creek via the United States Canal, it would meet the incoming flood from the Santee and be returned to Lagoon Creek.

Suppose Lagoon Creek was diked off on both sides of the canal, and the canal finished to sta. 208+30. Then, from the foregoing, it would seem very probable that the Santee flood would reach to the other side of sta. 208+30 toward Winyaw Bay, and beyond the half-way point from river to bay, and for the same reason as given, the Winyaw salt water would probably be returned by the Santee flood before it had time to reach Mosquito Creek.

Having constructed both dikes at Lagoon Creek, it would not only prevent the salt water from coming into the canal from the lagoons, but would also restore the general conditions of things as they were when Mosquito Creek was open from Santee River to Winyaw Bay. These dikes would give an additional protection to the canal in saving it from cross-currents and the probable formation of a troublesome shoal, and might be, it is thought, included in the work of the revetment.

Suppose the canal was finished to sta. 208+30, and its banks connected at Lagoon Creek by these dikes, would not these 3 miles of continuous wall, between the low-lying sea-beach and the rice fields near by, be advantageous rather than otherwise to the rice planter.

Were both dikes constructed at Lagoon Creek, and a tide lock also needed afterwards, I should think that the best place for the location of the lock would then be in the vicinity of sta. 208+30, where the Santee and Winyaw waters would probably be nearly in equilibrium; but should you deem a lock necessary and not the dikes, the only place to locate it would be just below Lagoon Creek, in the canal.

From what I can understand about the tide lock required, it can be simply constructed of creosoted wood, and arranged so that its gates or wings can be opened and closed at will.

The cost of a structure of this description would *possibly* be about as follows, but this rough estimate is liable to change as the matter may be more thoroughly examined. The chief cost would likely be in securing the foundations.

The lock to be 35 feet wide in the clear, and 60 feet long, with two sets of gates, and intended only to prevent the tide from flowing through at certain stages.

40,000 feet of creosoted lumber	$2,000
Pumping machinery, ten days, at $40	400
Iron work	400
Labor and contingencies	2,000
	4,800

Capt. James Mercur, Corps of Engineers, United States Army, mentions the possible necessity for a lock in the canal, in his report to the Chief of Engineers, United States Army, dated February 2, 1882.

The South Carolina legislature passed an act in January, 1882, of which the following is an extract, which explains itself:

"A BILL ceding the jurisdiction of the State of South Carolina to the United States of America, over such lands as may be required for connecting Winyaw Bay and Santee River, in Georgetown County, so as to facilitate commerce.

"*Be it enacted by the senate and house of representatives of the State of South Carolina, now met and sitting in general assembly, and by the authority of the same:*

"SECTION 1. That the jurisdiction of the State of South Carolina is hereby ceded to the United States of America over so much land as shall be necessary for the purpose of connecting Winyaw Bay and Santee River, in Georgetown County, so as to facilitate commercial intercourse on the waters thereof, said connection to be provided with a lock or flood-gate to protect the rice plantations which may be affected thereby, if the same may be deemed necessary by the United States Engineer in charge of the improvements."

The rice lands supposed to be in jeopardy from salt water are as follows: A statement by Mr. R. I'on Lowndes gives the total areas on Mosquito Creek as being 3,000 acres, and he places their value at $50 per acre. A statement by Mr. William Miles Hazzard gives the acreage, as owned by himself and situated on Minim Creek, above the Santee mouth of Mosquito, at 700 acres. He does not state their value, but I suppose it is no more than that as expressed by Mr. Lowndes.

Mr. Lowndes was asked why it was not possible to waste any impure water that might be in Mosquito Creek at low tide, through his lock on the flood, inasmuch as the Santee water rose first and highest. His reply was that he had been in the habit of thus disposing of the bad water, which Mosquito Creek had always been subject to more or less; but he feared that he would be unable to waste any water in excess of that spoken of, because then a sufficient head of water would not be retained on the Santee side to properly irrigate his lands.[18]

I would here thank Mr. Lowndes for many courtesies extended to me in my efforts in complying with your orders in the collection of data for this report. He spared no pains to further me in this work. I respectfully inclose a tabulated statement* furnished by him, giving the stages of the water in the Santee, Wateree, Congaree, and Pee Dee rivers, in the up-country, for certain periods, as will be seen by the statement. This may be useful or interesting to you in showing approximately the volume of fresh water the Santee contained during the time when we were keeping a record of the water in the United States Canal in the year 1884.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. W. H. BIXBY,
Corps of Engineers, U. S. A.

APPENDIX TO ASSISTANT ENGINEER WHITFORD'S REPORT.

Mr. R. I'on Lowndes, the representative of the persons claiming protection for their rice interests, came to my office on February 15, 1886, to talk over the subject with me. I read him all of Assistant Engineer Whitford's report (except the first few pages, which he had already read) and asked him to comment fully whenever he thought comments necessary to fully explain his side of the case. His comments, written out by me and revised by him, are herewith appended. The numbers correspond to numbers inserted by me in Mr. Whitford's report. Mr. Lowndes was several times asked to add more to his remarks, but thought finally that these eighteen comments covered all he needed to add to Mr. Whitford's report in order to make it fully cover his side of the question.

W. H. BIXBY,
Captain of Engineers.

[1] Most of this must go into the Santee end of Mosquito Creek and will injure their rice interests.

[2] Doubted, unless "an easterly" means only one that goes over the original banks; an ordinary easterly blow would not do this.

[3] Not unless it can get through the high banks already put up by the rice interests.

[4] This is the value of Mosquito Creek to the rice owners and why these lands are always able to make crops when men higher up the other rivers (not Santee) could not do so.

[5] But this never happens during the irrigating season.

[6] This was the dirty brackish water unfit for irrigating.

[7] Considerable, instead of very little.

[8] This water, a little brackish, is just as injurious to the rice planters as very salt water.

[9] This is all I claim. Moreover, there was a freshet in the Santee at the times these observations were taken; in summer, when the water is low, the flow of salt water from the Government cut will be much increased.

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* Omitted.

[10] This same centrifugal force acts in a similar way at the Santee end of the canal (where it empties into Mosquito Creek) to hold back the water in Mosquito Creek and to prevent the otherwise natural fall of ebb necessary to drain the rice lands in Mosquito Creek above the canal.

[11] But if Winyaw Bay were salt, as it would be during the irrigating months, the water in Lagoon Creek would be salt, and then the salt water from Winyaw would go through Lagoon Creek down the Government cut.

[12] This is true during the flush water season when Winyaw Bay is fresh at low water, but in the irrigating season, when Winyaw is salt at all stages of the tide, the water (then salt) would come from Winyaw into the lagoons, and from them on the ebb tide into the Government Canal and Mosquito Creek, as it comes now, fresh.

[13] In the summer this would not be true, as Winyaw would send as much salt water into Lagoon Creek and the lagoons as it is now sending fresh water; and this would make brackish the water which returns on the ebb from the lagoons into the Government cut and Mosquito Creek.

[14] This should be when the lower part of Mosquito Creek becomes salt on the last portion of the flood.

[15] This difference in the water level (as shown at my flood-gate) cannot be observed at any single point in the Government Canal, because the latter is always open; but it would exist if the Government Canal were closed by a flood-gate at its Lagoon Creek end. While the Government Canal remains open, the effect of this difference of level is to force the impure water of Lagoon Creek on ebb tide into Mosquito Creek, thereby poisoning the water of Mosquito Creek for irrigating purposes, keeping it that much fuller and thereby lessening the fall in said creek and thus impairing the drainage of my lands that lie on the creek, especially above the point where the Government cut enters it.

[16] I would call this to your attention: that my gate (which is a double gate opening both toward the Santee and Winyaw) is so arranged during the whole irrigating season that it automatically opens towards Winyaw to the allow Santee floods to pass, but automatically closes against Winyaw floods to keep them out. During the observations of Mr. Martin in February, 1886, the Santee gates were closed at his request, and consequently the heights on the Winyaw side were not as great as during the usual condition of affairs throughout the irrigating season. Also this: that in summer, when I am irrigating all my fields, say 900 acres, which lie all along on Mosquito Creek and on the canals leading to my gate, the water, while my trunks are open, cannot rise even high enough in the canal to open the gate; and the suction out of Mosquito Creek into my fields is so great that instead of the Santee water on the flood tide rising high enough to go far enough through your Government cut to push back the bad water in Lagoon Creek, the impure water of Lagoon Creek will be drawn by the great suction through your cut into Mosquito Creek or so far into your cut that it will be sure to enter Mosquito Creek on the early part of the following ebb tide. Please mention also that your observations of February 7, as to rise and fall of tides, were taken with all my lands dry and all outside doors to my trunks closed; and that with the usual condition of things during the irrigating season the height of Santee floods in Mosquito Creek would be much lessened, and the amount of fresh water in the creek will be much lessened.

[17] This was when Santee was in freshet, and Winyaw not as high as usual during freshet months.

[18] Moreover this impure water would fill the main irrigation canals (none of which are provided with gates, and for which gates would be inconvenient and costly), and this impure water would then intervene between the fields and the fresh water outside.

I am not seeking indemnity, but only protection against damage, and this protection is needed at once, as the planting season will soon be upon us.

[19] Omitted.

L 13.

IMPROVEMENT OF WATEREE RIVER, SOUTH CAROLINA.

The Wateree River, which unites with the Congaree to form the Santee, has (including its upper portion, called the Catawba) a total length of about 310 miles, and a drainage area of 5,642 square miles. This river, prior to governmental improvement in 1882, had a low-water depth of from 3 to 4 feet from its mouth in the Santee upward 64 miles to Camden, its practical limit of steam navigation. From its mouth upward 12 miles the river was completely blocked at all stages of water by sunken logs and stumps and by floating obstructions; thence 42 miles to Camden navigation was possible, but dangerous except during high water. Its commerce was then almost nothing.

The original project of 1881–'2, as continued to date, proposed for $54,000 to secure a safe and unobstructed 4-foot navigation over this entire distance at all stages of water.

Inadequate yearly appropriations, involving the alternate disorganization and reorganization of working parties, damage to unfinished work, extra superintendence, and deterioration of plant, have added about $4,000 to the cost of the work. The aggregate amount appropriated for this project up to 20th June, 1886, is $28,000. The present estimate (that of 1885), $58,000, for the final cost of the work, based upon the present condition of the river and past experience, agrees well with the original estimate.

Twenty-seven thousand nine hundred and sixty-five dollars and sixty-three cents have been spent in all upon this improvement up to 30th June, 1886, giving a thoroughly-cleared 4-foot navigation at all stages of water from the mouth of the river 7 miles upward, and thence a roughly-cleared 4-foot navigation over the rest of the river 57 miles to Camden. In consequence of this improvement a steamboat line would have been permanently established upon the whole length of this river had it not been prevented by the obstructions offered by two railroad bridges. Could these obstructions be removed a river commerce of $1,000,000 of transported goods per year would be at once developed.

The extent of this obstruction is shown by the following extract from special report, dated 17th January, 1885:

> Eight miles above its mouth in the Santee, this river is crossed by the Camden Branch of the South Carolina Railroad, on a wooden through bridge without a draw-span, the bottom of the bridge being 15.3 feet above low water. The use of this bridge without a draw has been specially authorized, as far as concerns the State of South Carolina, by State acts passed in 1853 and 1858.
>
> Thirteen miles above its mouth the river is also crossed by the Wilmington, Columbia and Augusta Railroad on a wooden deck bridge without a draw-span, the bottom of the bridge being about 17 feet above low water.
>
> The present improvement will probably be finished next year sufficiently to allow of a tolerably clear 4-foot navigation to steamers * * * over the whole river from its mouth up to Camden. The current of this river is swift and strong, especially during high water stages. Both bridges have already proved serious obstructions to a desired navigation.
>
> I therefore recommend that the owners of both these bridges be required to insert suitable draw-spans in their bridges; that the spans be at least 60 feet wide in the clear; that the opening be placed with reference to deep water and the convenience of navigation; that the openings be provided with strong and suitable fenders on both ends of the span, extending, say, 150 feet above and 80 feet below the bridge, and that these fenders should rise above ordinary high water to within about a foot of the draw-span's lower chord.

I would now modify the above recommendations so as to allow the Wilmington, Columbia and Augusta Railroad (if it so chooses) to dispense with a draw by raising its channel-span 21 feet, which can be readily done by converting its present deck bridge into a through bridge. This modification will place the bottom of the bridge 38 feet above low water.

The special work of the year has been as follows:

Expenditures, $238.46.

Owing to its variable features, and the difficulty of properly specifying it beforehand and inspecting it afterward, the work was allowably done by hired labor and the purchase of materials in open market.

A small survey of the river was made in June with a view of obtaining a map suitable for properly ordering and recording future work. This survey was very efficiently made by Assistant Engineer Charles Humphreys.

Other than this and office work and the care of the Government property nothing has been done for want of funds.

The general charge of the work has been under the immediate supervision of Assistant Engineer Reid Whitford. His full report (including a brief history of past work upon this improvement) is herewith appended.

Recommendations for future work are as follows:

That this improvement be completed in accordance with the present approved and adopted project, so as to secure a thoroughly-cleared 4-foot navigation over the entire river at all stages of water, at a total expense of $30,000, in addition to the $34.37 available 30th June, 1886, this amount to be appropriated in one sum during the next year. Smaller yearly appropriations will increase the cost of the work by from $1,000 to $4,000 per appropriation.

It is further strongly recommended that the South Carolina Railroad be required to put a draw-span in its low through bridge across the river, and that the Wilmington, Columbia and Augusta Railroad be required to either insert a draw span or to raise its present channel-span 21 feet.

Further improvement, so as to extend the navigation above Camden or to deepen that below Camden, is not recommended.

After the improvement is finished its proper maintenance may cost from $1,000 to $3,000 per year.

This improvement, as regards cost and order of work, should be carried on approximately as follows:

The entire length of river should be examined and improved uniformly each year.

During the low-water stage the most troublesome sunken logs and snags should be removed from the channel.

During the high-water stage the most troublesome leaning trees should be cut down and pulled back from the banks, as also such trees on caving banks as appear liable to fall into the river during the following year.

This river is in the collection district of Georgetown, S. C.

Money statement.

July 1, 1885, amount available		$272 83
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$3 71	
July 1, 1886, outstanding liabilities	234 75	
		238 46
July 1, 1886, amount available		34 37
Amount appropriated by act approved August 5, 1886		7,500 00
Amount available for fiscal year ending June 30, 1887		7,534 37
Amount (estimated) required for completion of existing project		25,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		25,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. REID WHITFORD, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Georgetown, S. C., March 11, 1886.

CAPTAIN: I have the honor to make the following report concerning the Wateree River, South Carolina, for fiscal year to date:

GENERAL FEATURES.

The Wateree River is merely a continuation of the Catawba.

The latter river heads in the Blue Ridge Mountains, McDowell County, North Carolina, near the Swananoa tunnel on the Western North Carolina Railroad, close to the main divide between the Atlantic and Mississippi basins.

It runs thence first easterly, then southerly, through portions of North and South Carolina, and takes the name "Wateree" at the junction with Wateree Creek, a small tributary entering from the west in the upper part of Fairfield County, South Carolina, some distance above the town of Camden.

The Wateree River derives all its characteristic features from the portion called the Catawba, and the name of Wateree is really a misnomer, or at least unnecessary.[*]

The Wateree after flowing on in a southerly direction for a distance of 105 miles[†] unites with Congaree and forms the Santee.

This latter river continues on in a southerly direction for a distance of 184 miles,[†][‡] and then empties its waters into the Atlantic Ocean 8 miles south of Winyaw Bay.

From the above it will be seen that the Wateree River draws its supply of water direct from the mountains and springs of Western North Carolina, and therefore it should possess greater navigable advantages than many other rivers which do not reach sufficiently near the main divide to secure a constant supply of water.

The Wateree drains an exceedingly fertile section of this State, from which there is shipped yearly a large amount of produce.

There seems to be but little doubt but that when the river is cleared from obstructions and open for traffic it will be of incalculable benefit to the people of its river basin and at once give strong impetus to the commerce of the country, thereby adding greatly to its prosperity. Camden, situated on the river, a town of some 2,500 or 3,000 inhabitants, is considered at present the head of navigation.

There is probably not less than 3 feet depth of water in the channel from that town to the ocean at the lower stages of the river.

The South Carolina Railroad Company owns and operates a railroad between Kingsville and Camden. There is no other railroad in that immediate vicinity.

The river will furnish means of transportation to much of the country not in easy reach of the railroad.

I would here state, before beginning on the history of the improvement of the Wateree River, that I thought it might be of interest to collect some facts dating far into the past in reference to this river. Through the kindness of Mr. Walter Hazard, a prominent lawyer of this place, I have been enabled to collect many interesting facts as to the various and thorough attempts to improve the navigation of the Catawba and Wateree rivers before their improvement was intrusted to the United States Government engineers.

HISTORY OF LOWER AND UPPER CATAWBA IMPROVEMENT.

1787. An act passed by the legislature of South Carolina on the 27th day of March, 1787, established a company consisting of eight men for the opening of the navigation of the Catawba River, South Carolina. This act authorized these eight men to do just about what they wished in order that the river might be made navigable, and further said that they might accomplish this either by dams, canals, and locks, or in any other manner which seemed to the said company to be most fit and convenient; and further, that they might charge boats, rafts, &c., any amount of toll for their passage till the dividends paid 25 per cent. on the invested capital, but it must not exceed these figures.

Previous to the year 1820 a company is said[§] to have endeavored, with State aid, to improve the navigation of this river, but with very little if any success.

1875. Col. S. T. Abert, United States civil engineer, estimated[‖] the cost and improvement at $2,000,000 for slackwater navigation, the only kind of navigation applicable to the river.

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[*] See Captain Phillips in his report, page 9146, Annual Report of Chief of Engineers, 1880.

[†] See Captain Phillips in his report, page 9146, Annual Report Chief of Engineers, 1880.

[‡] Captain Bixby's report, page 1120, Annual Report Chief of Engineers, 1885.

[§] Report W. A. Walbrect, page 913, Annual Report Chief of Engineers, 1880.

[‖] See Abert, page 367, Annual Report Chief of Engineers, 1886.

1879. The river and harbor act of March 3, 1879, provided for surveys or examinations of the Upper and Lower Catawba rivers. This work was placed in charge of Capt. Charles B. Phillips, Corps of Engineers, United States Army, the 12th of May following, and the examination was completed by the next autumn. Captain Phillips reported† that the Lower Catawba (that portion in South Carolina) was 55 miles in length; had a total fall of 325 feet; that owing to this great fall its improvement, except by a system of locks and dams, would be out of the question; that the cost of such improvement would be about $50,000 per mile; that inasmuch as its present and prospective demands of commerce were not sufficient to warrant this expenditure he did not consider the work a public necessity, and hence he recommended its (Catawba) improvement should not be undertaken.

Captain Phillips also reported* that the Upper Catawba (that portion in North Carolina) was 140 miles in length from Old Fort, N. C., where the examination was commenced, to where it crosses the State line, and had a total fall in that distance of 890 feet, and that, for reasons similar to those given above for the Catawba, he recommended that its improvement should not be undertaken.

WATEREE RIVER—HISTORY OF ITS IMPROVEMENT.

1753. On April 21 an act was passed by the general assembly of the Province of South Carolina providing for the improvement of this river.

It began by saying, "Whereas the making of the Wateree River navigable will be of great benefit to the inhabitants of that part of the Province, and tend to the better settlement thereof, we therefore humbly pray His Most Sacred Majesty that it may be enacted." The act specified the work to be done in the shape of taking away the rafts and other obstructions in said river, &c. It provided means of doing this work by levying a tax of 10 shillings on the 100 acres of land lying within 10 miles of the river, &c., owned and claimed by any person or persons who did not reside on the same, and that all the male inhabitants from the age of sixteen to sixty years living on either side of the river, &c., would be obliged to work at removing said obstructions whenever the five commissioners, appointed by this act to look after the work, should call on them.†

1784. On March 26 an act was passed by the general assembly of the State of South Carolina appropriating £300 sterling for the purpose of removing obstructions from the river as high up as Camden. Five commissioners were appointed by this act to put out the work by contract or otherwise have it done, to draw all moneys from the State treasury, settle all accounts, and have general direction of the whole work.‡

1785. On March 24 an act for clearing the Wateree was passed by the general assembly, but no details were given.

1787. An act to establish a company for the opening of the Wateree and Catawba rivers, South Carolina, was passed.§

1791. On February 9 an act was passed to open and improve the navigation on the Wateree River from the falls near Mr. Chestnut's ferry down to the confluence of the Wateree and Congaree.

Ten men were appointed to look after this work, and they were to be known as the "Wateree board of commissioners." The act further provided that all male inhabitants between the ages of sixteen and fifty years, living within 6 miles of said river, &c., were made liable to work on the river under direction of said commissioners, for the space of six days in a year and *no more*.‖

1805. On 19th December an act of this date appropriated $2,000 for the improvement of the river from Camden Ferry to the Congaree River. This act appointed seven men as commissioners to look after the work and make yearly reports to the comptroller-general explaining the progress made with the improvement, &c.¶

1879. On March 3 the river and harbor act passed by the Congress of the United States provided for an examination or survey of the Wateree River. This work was placed in the charge of Captain Phillips the 12th of May following, and the examination of the river from Wateree Creek to its mouth was completed by Assistant Engineer Walbrect as soon as he had finished with the similar examinations of the Catawbas heretofore mentioned. Mr. Walbrect said that there were two railroad bridges across the river which would have to be converted into draw-bridges if the improvement was ordered.

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* See page 911, Annual Report Chief of Engineers, 1880.

† See Statutes at Large of South Carolina, vol. vii, page 504.

‡ See Statutes at Large of South Carolina, vol. vii, page 532.

§ See under head of "Lower Catawba," this report, for fuller details.

‖ See Statutes at Large of South Carolina, vol. vii, page 562.

¶ See Statutes as Large of South Carolina, vol. vii, page 578.

Captain Phillips disapproved of the improvement of the upper 17 miles of the river* because it was a rapid mountainous stream like the Catawba, and had a total fall of 75 feet in that distance; he mentioned the fact that a small light-draught steamer was then being run on the river, engaged in purely a local traffic, and he submitted a project for improving the remaining portion of the river by removing obstructions such as fallen and overhanging trees, snags, &c., so as to secure a local depth of 3 feet at low water in the channel at an expenditure of $30,000.

1880. The river and harbor act of June 14, 1880, provided for an examination or survey of the Wateree River from Camden to its mouth. This work was assigned to the charge of Captain Phillips June 17, same year. The field work was intrusted to Assistant Engineer J. P. Darling, who began it in October and finished it in November, same year.

1881. Captain Phillips submitted a project for the improvement of the river at a cost of about $54,000, which contemplated securing a depth of 4 feet in a channel 80 feet wide from Camden down, by the removal of all obstructing logs and snags and the cutting off of fine projecting points.† This project was approved and the river and harbor act of March 3 appropriated $8,000 for this work. Capt. James Mercur, Corps of Engineers, United States Army, assumed charge of this work June 14, 1881, upon the death of Captain Phillips.

1882. The work of clearing the river of obstructions as approved was commenced in January with H. Heth, assistant engineer, in local charge. A steam hoister was hired and set at work at the mouth of the river, and its work confined to that portion of the river between the mouth of the river and the South Carolina Railroad Bridge, a distance of 8 miles. This hoister, after working till April 29, was entirely disabled by the explosion of one of her boilers. No other hoister being available for work, operations were confined to cutting the overhanging growth from the river banks between points above named.‡ In Captain Mercur's report no detailed statement of work done was given, and the exact date of stoppage of work was not mentioned. The river was represented as being badly choked with fallen timber, and that simply the most prominent obstructions were removed as high up as the railroad bridge, and the report further implied that very much more was necessary to be done on that section of the stream. Especial attention was called to the railroad bridges across the river as obstructing the passage of vessels with masts, smoke-stacks, &c.

1882-'83. The river and harbor act of August 2 appropriated $15,000 for this river. Work during the year was continued under the existing project. At the close of the fiscal year 1882 operations were suspended because of the exhaustion of available funds. High water preventing, work was not resumed till 1883, in May, when a steam hoister was hired for the purpose. She worked from 5th of May till 17th of June, this year, below the first railroad bridge, completing that portion of the river. The hoister then proceeded upon a trip of examination to Camden, and while only drawing 1.5 feet still reported difficulty in passing some of the obstructions, so numerous and formidable were they. Amongst other things it was reported (13) that the river commerce had been formerly carried on between Camden and the Wilmington, Columbia and Augusta Railroad Bridge, which crossed this river 5 miles above the South Carolina Railroad, by one steamboat, but the boat having met with several accidents, &c., she was abandoned, her machinery removed and sold.§

1883-'84. Work was continued under the direction of Captain Mercur till March, 1884, when he was succeeded by Capt. F. A. Hinman, Corps of Engineers. Owing to the near exhaustion of funds, work was again stopped on March 23, 1884. To that time from end of previous fiscal year the work was carried on by H. Heth, assistant engineer in local charge. The work of this year was reported‖ as done between Camden and the junction of this river with the Congaree, a distance of probably 96 miles. Of this the 45 miles from Camden down was reported as effectually cleared so as to secure a channel 60 feet wide and 4 feet deep. A little work was also done in the 12 miles of the river immediately above the junction with the Congaree. During the progress of this work 1,383 logs and snags were taken from the bed of the river, and 2,725 overhanging trees removed from the banks.

1884-'85. The river and harbor act of July 5, 1884, appropriated $5,000 for this work. Reid Whitford, assistant engineer, was placed in local charge of the work by Captain Hinman in May of the same year. Captain Hinman was succeeded by Capt. W. H Bixby, Corps of Engineers, United States Army, in 1884. Under this new appropriation work was resumed at the mouth of the river 7th November, 1884, and continued with a self-propelling steam hoister until the 15th of April, 1885, when the available funds became exhausted and operations were once more suspended. During this time the river was thoroughly cleared of obstructions from where the machine began to a point 4.5 miles above and roughly cleared from this place to Camden, its head of navigation. There was removed a total of 297 (in all since 1882) logs, large and small, 63 stumps (since 1882), 30 cords of snags, and 2,533 square yards of rafts or floating material from the bed or channel of the river, and 385 overhanging trees were cut and removed from the banks. During the low-water season of 1884 40 inexpensive water gauges were established between the mouth of the river and Camden, and the dead low-water level was noted at each. The railroad bridges across the river prevented the hoister from passing up as soon as was desirable. Special attention was again called to the obstructions which these bridges offered to the river navigation,* and it was strongly recommended † that their owners be required to supply them with suitable draw-openings. In accordance with already approved and adopted project, an expenditure of $30,000 was recommended for the completion of the work to Camden.‡

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* See Report of Chief of Engineers for 1880, page 915.

† See Report of Chief of Engineers for 1881, page 1034.

‡ See Report of Chief of Engineers for 1882, page 1111.

§ See Chief of Engineers' Report for 1883, page 871.

‖ See Chief of Engineers' Report for 1884, page 1051.

1886. There has been no work done on this stream since June 1, 1885.

In taking a retrospective view of the foregoing it will be seen that the improvement of this river has been carried on at intervals, so far, from the year 1753 to 1886, or covering a space of one hundred and thirty-five years, under different appropriations and governments, as follows:

1753. By the colonial government of South Carolina levying a special local tax on lands and by the labor of the local inhabitants thereof.

1784. By the State government of South Carolina appropriating 300 pounds sterling.

1785. By the State government of South Carolina an ordinance (details not given).

1787. By the State government of South Carolina establishing a company.

1791. By the State government of South Carolina, local inhabitants performing labor.

1805. By the State government of South Carolina appropriating $2,000.

1881. By the Government of the United States appropriating $8,000.

1882. By the Government of the United States appropriating $15,000.

1884. By the Government of the United States appropriating $5,000.

The following distances, &c., are summed up from reports of Captain Phillips, United States Engineer, except the first therein, which was taken from postal map of North Carolina:

	Miles.
Via Upper Catawba River from its head to Old Fort (fall not given)	10
Via Upper Catawba River from Old Fort to North Carolina line (total fall 890 feet)	140
Via Lower Catawba River from North Carolina line to Wateree River (total fall 325 feet)	55
Via upper Wateree River from Wateree Creek to Camden (fall not given)	41
Via Lower Wateree River from Camden to Congaree and Santee (fall not given)	64
Via Lower Santee River from its head to the ocean	184
Total length	494

RECOMMENDATIONS FOR NEXT SEASON'S WORK.

I would respectfully offer for your consideration the following recommendations for next season's work.

Owing to the difficulty of properly classifying the work, that it be done by hired labor and machinery. To this end it is thought from past experience that it is important for the hoisters employed upon this river to be self-propelling and capable of steaming at least 1¼ miles per hour against the current in the river.

That as a rule the removal of obstructions from the bed of the river should be done during the low water or when the water is not over 3 feet above its dead low stage.

That by exception rafts and floating material should be taken out at all stages of water, as the removal of them is quite as essential as the removal of obstructions from the bed of the river, because if not attended to these rafts soon accumulate to such an extent as to form perfect jams from bottom of river to surface of water.

That the cutting of growth from banks be done when the water is too high for other work, and that when possible the trees should be taken up with their roots by blasting or blowing away the earth with jets of water discharged through pipes by strong force-pumps, so that no stumps will be left projecting to fall in the channel as the banks continue to erode under action of the current. I should think that it would be best to conduct operations by working from the mouth of the river to Camden, removing the most troublesome obstructions, then work back, widening and improving the channel, and so on back and forth till the work was completed.

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* See report of Captain Bixby to Chief of Engineers, dated January 17, 1885.

† See Annual Report Chief of Engineers, year 1885.

‡ Report of Captain Bixby to Chief of Engineers for 1885.

It is not recommended that any attempt be made to thoroughly clear any particular section of the river at first to the exclusion of work on other portions.

COMMERCE.

There is no change in the prospective commerce on this river since the date of my annual report that is known to myself.

I would state, however, that during the spring of 1885, soon after the work on the river stopped, the South Carolina Steamboat Company attempted to run a steamboat to Camden, and by the quantity of freight offered for shipment they were encouraged not only to continue this boat, but to put others on the river. After enduring many perplexing and expensive delays at the railroad bridge they finally took the boat off the line to await the action of the railroad companies in supplying their bridges with draw openings.

Very respectfully, your obedient servant,

REID WHITFORD,
Assistant Engineer.

Capt. WILLIAM H. BIXBY,
Corps of Engineers, U. S. A.

L 14.

REMOVING SUNKEN VESSELS OBSTRUCTING OR ENDANGERING NAVIGATION.

On the 16th February, 1886, the Board of Commissioners of Navigation and Pilotage, of Wilmington, N. C., made formal complaint that there were two wrecks in the river below Wilmington which were within or on the edge of the channel and endangered or obstructed navigation.

Examination elicited the following information:

The British brig Clio was built at Prince Edward Island in 1861. She was a wooden vessel of 105 feet in length, 25 feet beam, and 12 feet depth. This vessel was loaded at Wilmington about the year 1871, and was wrecked on the Rip of Oak Island Channel, at the mouth of the river, 19 miles below Wilmington. After the cargo was taken out she drifted back into the river, burnt to the water's edge, and sunk at a point about a half mile above the Price's Creek light-house and toward the western side of Snow's Marsh Channel. In February, 1885, the wreck lay in from 11 to 13 feet depth of water. Portions of the wreck rose to within 4 feet of the water surface and other portions descended to probably 16, but possibly 20, feet below the water surface.

The side-wheel steamer North Heath was a blockade-runner during the late war. At or about the time of the capture of Fort Fisher, in 1865, she was taken by the Confederate authorities and sunk in the main channel of the river, near the head of Clark's Island, about 3 miles below Wilmington, as an obstruction to navigation. She was an iron side-wheel light-draught steamer of from 200 to 250 feet in length. Her upper works were above the water surface for several years, and then certain parties, by the use of explosives, removed as much of the wreck as was profitable to them and left the remainder. In February, 1885, the wreck lay in from 17 to 20 feet depth of water. Portions of this wreck rose to within 7 feet of the water surface and other portions descended to 23 feet below the water surface.

The natural bottom in both places was mud, but the accumulation of sand was to be expected around the wrecks.

There was probably nothing about either wreck of any value or worth saving.

In accordance with the provisions of section 4 of the act of 14th June, 1880, thirty days' notice was given to all persons interested in these wrecks; and in default of the appearance of any such persons, the removal of these wrecks was duly advertised. Proposals were opened 7th June, 1886, and a contract with the lowest bidder, the American Dredging Company, was approved on the 23d June, they agreeing for $7,500 to completely remove the wrecks within four months from the signing of the contracts.

There were no expenditures for this work prior to 30th June, 1886.

Work will probably commence promptly in July.

The provisions of section 4 of the act of the 14th June, 1880, require that in all such cases of the removal of such wrecks "all property therein when so removed shall, after reasonable notice of the time and place of sale, be sold to the highest bidder or bidders for cash, and the proceeds of such sale shall be deposited in the Treasury of the United States to the credit of a fund for the removal of such obstructions to navigation, under the direction of the Secretary of War." In this particular case there is probably hardly anything about either wreck that will sell for the amount of money that its removal will cost the contractor. Under such circumstances, the contractor will be obliged to do a large amount of otherwise unnecessary labor in landing this property, and as his bid was of course based on the necessity of performing this otherwise unnecessary labor, the Government will, in the end, have paid for the property much more than it will have received, and will be the loser by the whole operation.

I am satisfied that in this particular case the proposals would have been much lower and the final cost of removal of the wrecks much less to the Government could the wreck have become the property of the contractor after its removal. I have therefore to recommend that the act of the 14th of June, 1880, be so modified as to allow the Secretary of War, before advertising the removal of the wreck, to decide whether or not the property when removed shall belong to the contractor or to the Government. In my opinion some such modification would result in economy to the Government.

Abstract of proposals for removing wrecks of brig Clio and steamer North Heath from Cape Fear River, North Carolina, opened June 7, 1886, by Capt. W. H. Bixby, Corps of Engineers, United States Army.

No.	Names and addresses.	Price bid (total sum).
1	William E. Chapman, Brooklyn, N. Y	$9,970
2	R. P. Bowdoin, Wilmington, N. C	16,000
3	Rittenhouse Moore, Mobile, Ala	10,987
4	American Dredging Company, Philadelphia, Pa	7,500

Contract awarded to American Dredging Company.

APPENDIX M.

IMPROVEMENT OF RIVERS AND HARBORS ON THE COAST OF SOUTH CAROLINA AND GEORGIA, AND PART OF THE ATLANTIC COAST OF FLORIDA.

REPORT OF COLONEL Q. A. GILLMORE, CORPS OF ENGINEERS, BVT. MAJ. GEN. U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Charleston Harbor, South Carolina.
2. Wappoo Cut, South Carolina.
3. Ashley River, South Carolina.
4. Edisto River, South Carolina.
5. Salkiehatchie River, South Carolina.
6. Savannah Harbor and River, Georgia.
7. Savannah River, Georgia.
8. Savannah River above Augusta, Ga.
9. Saint Augustine Creek (Thunderbolt River), Georgia.
10. Romerly Marsh, Georgia.
11. Altamaha River, Georgia.
12. Brunswick Harbor, Georgia.
13. Entrance to Cumberland Sound, Georgia and Florida.
14. Inside passage between Fernandina and Saint John's River, Florida.

UNITED STATES ENGINEER OFFICE,
New York, July 31, 1886.

GENERAL: I have the honor to transmit herewith my annual reports upon the works of river and harbor improvement under my charge for the fiscal year ending June 30, 1886.

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Colonel of Engineers,
Bvt. Maj. Gen., U. S. A.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

M 1.

IMPROVEMENT OF THE HARBOR AT CHARLESTON, INCLUDING SULLIVAN'S ISLAND, SOUTH CAROLINA.

During the fiscal year ending June 30, 1886, operations for improving the entrance into Charleston Harbor, South Carolina, were carried on in conformity to the plan submitted in my communication to the Chief of Engineers, dated March 9, 1878, and printed as Appendix H of the Annual Report of the Chief of Engineers, 1878.

By this project it is designed to establish and maintain by means of two jetties a low-water channel of not less than 21 feet depth across the bar, upon which the greatest available depth has heretofore been only 11½ feet. The estimated cost of the project was $3,000,000.

Previous to the spring of 1878 there had been expended by the General Government in the improvement of the ship-channels in Charleston Harbor, subsequent to the close of the civil war (from 1871 to 1878), the sum of $93,700 in taking up the wrecks of fourteen iron-clad and wooden vessels sunk during the war, and in removing a portion of the Bowman Jetty projecting into Beach Channel.

RECAPITULATION OF OPERATIONS PREVIOUS TO JUNE, 1885.

North jetty.—This work was commenced in December, 1878. On June 30, 1885, the seaward end of the bottom course of the jetty had reached a point 14,327 feet from the starting point on Sullivan's Island measured along the axis of the work. No work had been done upon this jetty since November, 1881.

The width of this bottom course varied from 43 feet at shore to 118 feet at the sea end, and its height from 2½ to 4 feet. A second course of mattresses, varying from 66 feet to 81 feet in width, was laid over the bottom course for a length of 1,648 feet from a point about 7,600 feet from Sullivan's Island seaward, the height of this portion of the jetty being thereby increased to 5½ or 6 feet. The gaps formerly left on Drunken Dick Shoal was closed by a foundation course of 1,663 feet in length, 64 feet in width, and 3¾ feet to 4 feet in height. South of that shoal the jetty was raised by distributing riprap-stone over it. In some places the height thus attained was from 13 to 14 feet from the bottom.

Up to June 30, 1885, the aggregrate amount of riprap-stone placed upon the north jetty was 93,902 cubic yards. The mattress work, of an average thickness of 18 inches, composed of logs and brush, amounted to 144,077 square yards.

South jetty.—This work was commenced in April, 1880. On June 30, 1885, the bottom course extended to a point 15,884 feet from the original starting point on the shore of Morris Island, or 16,397 feet from high-water mark of June 30, 1884, to which point the jetty was extended about three years ago as a precaution to prevent the sea from cutting around the original end of the foundation course. The seaward end of that course had reached a point beyond the last shoal upon the crest of the bar, resting in a depth of 8 feet at mean low water. This point was about 2,400 feet from the 18-foot low-water curve of the outer slope of the bar.

The jetty after passing the shoal water along the eastern coast of Morris Island crosses the existing main ship-channel, which runs about parallel to the shore of the island, with a maximum depth in the immediate vicinity of the work of nearly 40 feet at mean low water; further east it crosses a deep pocket with low-water depths of from 18 to 25 feet.

From its starting point on Morris Island the jetty is laid upon a straight course, bearing south 87 degrees, east for a length of about 8,660 feet. Thence the axis of the work is laid on chords of about 400 feet length each, corresponding to a circular arc of about 1⅞ miles radius, until it reaches a point 2,900 feet from the straight seaward portion of the north jetty. From this point a straight course tangential to the curve and parallel to the straight portion of the north jetty is followed for a length of 2,288 feet.

The foundation course consists of log-and-brush mattresses overlaid with riprap stone, as described in former reports. The layer of stone varies from 12 to 14 inches in thickness; the mattresses average 18 inches in thickness.

For a continuous length of somewhat over 3,000 feet, beginning at the shore-end, the width of the mattresses varies from 40 to 42 feet. On the next reach of about 4,000 feet the width gradually increases from 42 to 108 feet, and the latter width has been maintained to the seaward end of the work, with the exception of a number of mattresses of 130 feet width, which were introduced at intervals, projecting from 6 to 15 feet on either side of the regular foundation course. The projecting portions were intended to act as short spurs. This arrangement commences at a point about 8,000 feet from the present shore-end of the jetty and extends 2,600 feet seaward.

As a further provision against scour, more or less parallel to the axis of the jetty, which developed while the latter gradually approached the crest of the bar, the foundation-courses of longer spurs were distributed along the work, beginning at a point about 11,000 feet from the shore-end and extending 2,900 feet seaward. These spurs were arranged in pairs on opposite sides of the main or central bottom course, projecting about 100 feet beyond the corresponding edge of said course. The foundations of fifteen pairs of such spur-jetties were laid, placed about 200 feet from center to center.

Where the jetty crosses the present main ship-channel, at which place the work will ultimately have a considerable height, the original width of the foundation-course was increased to from 135 feet to 205 feet by laying an apron of log-and-brush mattresses, covered with from 12 to 18 inches of stone, along the south edge of the course. This widening begins at a point 5,360 feet from the present shore-end, and extends a length of 1,570 feet seaward.

A second course of mattresses, overlaid with riprap-stone, was placed upon portions of the bottom course. This second course was not continuous, but was laid in four detached sections of an aggregate length of 10,586 feet.

The section nearest to Morris Island commences at the original shore-end. It is composed of mattresses 40 feet wide, with 24 inches of stone, and extends seaward 446 feet.

The next section, 40 to 50 feet in width, with from 12 to 16 inches of stone, was laid for a length of 1,554 feet, where the jetty crosses the main ship-channel, beginning at a point 5,360 feet distant from the high-water line on shore.

The third section, 44 to 50 feet wide, with 18 inches of stone, was placed from a point 7,047 feet from shore to a point 9,019 feet out a length of 1,972 feet.

A fourth section, formed of mattresses 50 to 55 feet wide, with from 12 to 17 inches of stone, extends seaward 6,614 feet from a point about 9,500 feet from the present shore-end, and reaches to within less than 270 feet of the outer end of the bottom course.

Dredging on the bar.—Dredging between the jetties was commenced May 20, 1885, on a range about coincident with the line of the greatest scour produced by the jetties; 8,929 cubic yards of materiel, consisting of sand and fine, light shells, had been removed at the close of that fiscal year.

Surveys.—A large amount of field work has been necessary in connection with carrying out the project for improving the entrance to Charleston Harbor. Special examinations, including borings and current observations, for locating the jetties were required, and since 1881 five, more or less, extensive hydrographic surveys of the outer harbor and bar, and one survey of the entire inner harbor, have been made. A well-developed system of triangulation, adopted over five years ago, has served as a basis for these and future surveys.

Sullivan's Island.—Some work has been done here during the last few years with a view of protecting the sea-shore of the island.

In December, 1880, a spur-dike, consisting of log-rafts covered with riprap-stone, 324 feet long, was built on the beach 3,050 feet east of Fort Moultrie and 2,300 feet west of the shore-end of the north jetty, under a special appropriation. A similar work 288 feet in length, 1,750 feet east of Fort Moultrie, was constructed in September, 1881, with funds from the regular appropriation for improving Charleston Harbor.

Mount Pleasant.—This place is situated in the bight formed by Hog Island Channel, 3 miles from the city of Charleston.

During the fiscal year ending June 30, 1885, two spur-dikes were built for the purpose of stopping the washing away of the shore-line, which had been progressing for several years. One, 477 feet in length, is situated about 1,750 feet southeast of the ferry-boat wharf; the other, 475 feet long, about 950 feet lower down. The sum of $5,000, expended upon these dikes, was included in the appropriation made July 5, 1884, for improving Charleston Harbor. They form only part of a plan devised to protect the whole line of shore referred to. It is not, however, considered that this work in any proper sense constitutes an integral part of the existing project for improving the harbor approved and begun in 1878.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

On July 1, 1885, a balance of $97,267.92 was available for continuing the improvement. The work upon the jetties and dredging between their seaward ends was continued under the contracts of which the details were given in my last annual report.

North jetty.—At the beginning of the fiscal year it became apparent that it would be desirable to reduce as much as possible the volume of water passing northward across the jetty in order to promote the excavation of the cut being dredged across Swash Reef, a shoal projecting northward from the seaward part of the south jetty to about midway between the two jetties.

With this object in view a second course of mattresses, 55 feet wide, with about 12 inches of riprap-stone, was laid over the foundation-course, extending 2,030 feet seaward from a point 11,090 feet from the shore of Sullivan's Island, measured along the axis of the work.

For the purpose of gaining height more rapidly where it would promise the most favorable results a ridge or longitudinal pile of riprap-stone was deposited upon the existing work along the center line of the jetty, beginning at a point 9,193 feet from the shore and carried seaward for a continuous length of 4,485 feet, embracing parts of both the curved and the straight portions of the jetty, and covering all the second-course work laid during the fiscal year and portions of the bottom course laid in former years. The outer end of this ridge reaches to within about 560 feet of the present seaward end of the bottom course. It was triangular in cross-section, nominally of 5 feet average height in the center line, with natural side slopes.

By the second course and ridge-work constructed during the past fiscal year the average height of the north jetty was raised along its axis for a length of 4,485 feet, from about 3½ feet, which it previously had, to about 8½ feet; but this height was subsequently reduced, the stone being gradually leveled down by the action of the waves.

At the end of the fiscal year the seaward end of the jetty was 1,200 feet within the outer 18-foot curve of the bar, measured along the prolongation of the axis of the work.

The material expended on this jetty during the year amounted to 12,001 square yards of log-and-brush mattresses and 7,593 cubic yards of riprap-stone.

From the beginning of operations to June 30, 1886, 156,078 square yards of mattresses and 101,495 cubic yards of riprap-stone have been used.

South jetty.—The foundation-course was extended 43 feet seaward during the first month of the fiscal year. Work was then discontinued upon this course, as it was not apparent that further extension at that time would produce as beneficial results as work that could be done at other points of the jetty.

A third course of mattresses, 44 feet in width, was next placed upon that section of the second course which was laid about two and a half years ago, over the foundation course where it crosses the deep pocket east of the main ship channel. This work was required to fill up to some extent the depression that here existed in the crest-line of the jetty, and to diminish the very large volume of water flowing southward along the low parts of the structure during ebb-tide. The currents here being very strong, the mattresses received a covering of stone of an average thickness of 16 inches.

This third course commences at a point 7,986 feet from the shore-end of the jetty, and extends 1,206 feet seaward.

To expedite the confinement of the currents between the seaward ends of the two jetties, it was decided to expend the balance of funds remaining on hand for jetty work, in September, in building a ridge of riprap stone along the center line of the jetty upon work already laid. A greater height could be secured in this way with the same amount of money than by the slower though more substantial process of building regular courses of broad log and brush mattresses and riprap stone.

This ridge was similar to that built on the north jetty, except that the nominal height of its crest-line was but 4.6 feet. Its inner end is coincident with that of the third course just described. It rests upon that course as far as the latter was built, and extends seaward by a continuous length of 6,038 feet, reaching to a point about 2,400 feet inside of the present seaward end of the foundation course of the south jetty.

In June, 1885, before the third course and the ridge of stone over it had been built, the low-water depths over the top of the work averaged 14 feet. In June, 1886, the depths had been reduced to 10 feet. The height of the ridge of stone had in the mean time been diminished by the action of the waves; otherwise the reduction of depth would have been greater.

From the outer end of the third course to the furthest seaward point to which the ridge has been constructed, a length of over nine-tenths of a mile, the original low-water depths before any work had been done varied between 9 and 18 feet, averaging 14.6 feet. In June, 1885, the depths of water over this section averaged 8 feet, while in June, 1886, the average depth was 5.4 feet, taken along the highest part of the work.

At and near the seaward end of the ridge its crest is bare at low tide, and for a considerable distance back there are but a few feet of water over it. At the end of the fiscal year the seaward end was 2,500 feet from the outer 12-foot curve of the bar, measured in the prolongation of the axis of the jetty.

The ridge work of the south jetty formed the concluding operations upon the jetties during the fiscal year. The contract with Mr. A. A. Howlett was terminated January 19, 1886. From July 1, 1885, to the last-named date the contractor put 6,288 square yards of mattresses and 7,748 cubic yards of stone in his work on the south jetty. From the beginning of operations to the present time there have been used in constructing the south jetty 287,038 square yards of mattresses and 124,147 cubic yards of riprap-stone.

Summary of work done on both jetties from beginning of operations to June 30, 1886.

	Feet.
North jetty:	
Length of bottom course from Sullivan's Island	14,327
Length of second course, mattresses and stone	1,648
Length of ridge work, all stone	4,485
South jetty:	
Length of bottom course from high-water mark on Morris Island	16,440
Length of second course, mattresses and stone	10,586
Length of third course, mattresses and stone	1,206
Length of ridge work, all stone	6,038

The material used in the work on both jetties aggregated 443,116 square yards of log and brush mattresses, averaging 18 inches in thickness, and 225,642 cubic yards of stone, equivalent in weight to about 270,000 gross tons.

Dredging on the bar.—Dredging between the jetties was carried on upon the range adopted when the work was commenced in May, 1885. The range runs nearly but not quite parallel to the straight seaward portions of the jetties, and is located about 1,000 feet from the south jetty. It was selected as being approximately upon the line on which the strongest ebb currents had recently developed more distinctly their scouring effects, and as forming a suitable and comparatively short connection between the 18-foot low-water curves of the inner and outer slopes of the bar. It was not expected that a through cut of that depth could be obtained with the funds then available, but it was proposed to create a channel of as uniform and great a depth as possible, with the expectation that a through cut, even of inferior depth, would prove useful in guiding the currents in a proper direction.

The more troublesome part of the work was presented by the northeasterly end of the spit known as Swash Reef, which was crossed by the line of dredging for a distance of about 1,000 feet with a minimum low-water depth of 7.7 feet. This shoal could not be avoided without adopting another line with somewhat better depths but considerably longer between the inner and outer curves to be joined.

The cut passed also through the westerly and deeper part of "Jim Evans Shoal," which, starting from a point of the north jetty about five-eighths of a mile from its seaward end, runs east and west half-way across the space between the two jetties. Its width was about 75 feet and its least depth 11 feet at mean low water.

The material raised by the dredging machines was nowhere found to be of such a nature that it could not be lifted readily, or, when simply stirred, taken up by the currents developed during the latter stages of normal ebb tides. With regard to the latter point we need not even except a sort of deposit of comparatively large sized, but broken shells with but little sand, met with in the relatively deeper water between Jim Evans Shoal and Swash Reef. This material formed no obstruction whatever to the suction power of the dredge, and it is anticipated that it can easily be moved and carried out by the concentrated currents, as soon as the knoll which Swash Reef forms between this deposit and the deeper water beyond the crest of the bar shall have been sufficiently lowered.

Swash Reef and Jim Evans Shoal, where traversed by the line of dredging, were found to be composed of rather coarse sand mixed with numerous small or greatly comminuted larger shells, while on the outer slope of Swash Reef and of the bar the material consisted almost entirely of very fine, light gray sand, with traces only of extremely diminutive fragments of small shells.

From the experience gained during the recent dredging operations, it is thought that the sea bottom of the area comprised between the jetties, where it is designed to locate the new channel, presents no difficulties to its establishment and maintenance whenever the necessary concentration of currents shall have been permanently secured.

From July 1 to December 31, 1885, when the contract was terminated, 76,620 cubic yards of material were excavated, making a total of 85,549 cubic yards removed under the contract.

CONDITION AND EFFECTS OF THE WORKS AND CHANGES IN THE HARBOR AND ON THE BAR.

The north and south jetties.—Portions of the north jetty, located on Drunken Dick Shoal, about 6,000 feet from the shore end, are nearly buried in sand which has accumulated. Some settlement could be noted for a short distance only in the vicinity. Near and at the seaward end of the jetty the work seems to be a good deal broken up. The depths of water here have generally increased since this part of the apron was laid. The stone ridge work placed upon the seaward portion of the jetty during the last fiscal year was, at the end of that period, found to be about 2 feet in height on an average, it having been leveled down by the action of the waves.

The extreme shore end of the south jetty settled some 2 feet, and a considerable quantity of stone was washed off it during the cyclone of August 25, 1885, which caused so much destruction to the buildings and wharves of the city of Charleston. Otherwise the jetties seems to have escaped injury. Where the south jetty crosses the deep pocket east of the existing main ship-channel, from 7,000 to 9,000 feet from shore, considerable scour has developed on the southern side of the apron, due to the overpour of the ebb tide, the currents of which cross the work nearly at right angles. A sort of trench is thus formed beyond the ends of the logs of the mattresses, which at the point of greatest scour is about 250 feet wide and 13 feet below the original bottom. Although a careful examination has failed to show that the jetty has settled at this point, it is evident that precautionary measures should be taken here as soon as possible. The outer portion of the jetty for a length of about 2,000 feet has settled from 1 to 3 feet; the greatest settling has taken place at the extreme end, where breakers prevail. The ridge of riprap stone deposited during the past fiscal year has been levelled down as in the case of the north jetty. At extreme low water some of the work near the outer end of the south jetty is exposed to view. The stone seems to be tolerably well distributed over the mattresses, but no signs of the growth of shell-fish, barnacles, &c., to the rock were discovered. Exposed logs show traces of the work of the teredo.

Numerous careful soundings taken in June last over the crests and along the sides of both jetties have furnished data for revised approximate calculations, serving for a comparison between the present hydraulic status of the improvement and its ultimate condition as required under the existing project.

The following statement is submitted:

NORTH JETTY.

Low-water areas and depths over present length of 14,327 *feet.*

Over original sea-bottom area	square feet..	157,700
Mean depth	feet..	10.87
On June 30, 1886, area	square feet..	86,780
Mean depth	feet..	6.06
Reduced as required by project, area	square feet..	30,526
Mean depth	feet..	2.13

Heights of work.

Average height required according to project	feet..	10.66
Average height June 30, 1886	do....	4.95
Height yet to be added to the jetty	do....	5.71

Areas of water-way at high tide; mean rise and fall of tides, 5.1 *feet.*

On site of north jetty, over original sea bottom	square feet..	230,768
Actual water-way across the work on June 30, 1886	do....	159,848
Water-way to exist after completion of project	do....	78,137

Present contraction of water-way equals 46½ per cent. of ultimate contraction required.

SOUTH JETTY.

Low-water areas and depths over present length of 16,440 *feet.*

Over original sea bottom, area	square feet..	238,610
Mean depth	feet..	14.51
On June 30, 1886, area	square feet..	140,760
Mean depth	feet..	8.56
Reduced as required by project, area	square feet..	74,940
Mean depth	feet..	4.56

Height of work.

Average height required according to project	feet..	11.23
Average height on June 30, 1886	do....	5.95
Height yet to be added to the jetty	do....	5.28

Areas of water-way at high tide; mean rise and fall of tides, 5.1 *feet.*

On site of south jetty over original sea bottom	square feet..	322,454
Actual water-way across the work on June 30, 1886	do....	224,604
Water-way to exist after completing the project	do....	138,084

Present contraction of water-way equals 53 per cent. of ultimate contraction required.

These results show that a large amount of work is still required in contracting the water-ways by raising both jetties to a higher level, in order to secure such a concentration of the ebb currents between the jetties as will produce scour of sufficient strength to create or to aid in creating the proposed new channel and to maintain it.

SWASH CHANNEL* AND THE BAR.

Jim Evans Shoal has not materially changed in size within the 9-foot low-water curve during the past year, but the portion joining the north jetty has narrowed and pushed seaward. The shoal reaches in a southwesterly direction about two-thirds of the way across the space between the jetties.

Swash Reef, with its base on the south jetty near its outer end, extends in a northeasterly direction about one-third of the way toward the north jetty; its area confined within the 9-foot curve has been reduced about one-half compared with that of the preceding fiscal year.

The cut formed by dredging across the northern end of Swash Reef has shoaled in some parts and deepened in others. The examination made at the end of the past fiscal year has shown that at points where the shoalest water was found previous to dredging the depth was increased 1.6 feet. It is clear, not only that in order to secure more satisfactory results, a much more powerful dredging apparatus, aided possibly by scraping and plowing, with a corresponding allotment of funds for applying it, must be employed, but that the work on the jetties must also be vigorously pushed, so that the more concentrated currents between them may have sufficient strength to keep the dredged cuts open.

No examination has been made during the past fiscal year of the Beach, Pumpkin Hill, or South channels. It is to be noted, however, that Pumpkin Hill Channel, which for a number of years was the bar-channel proper by which vessels reached the main ship-channel, has been in disuse for a few months past. The channel at present used is practically a southerly prolongation of the main ship-channel. In approaching from the sea the sailing line crosses the outer 18-foot curve of the bar at a point about 3 miles southeast of the mouth of Light-House Inlet, and runs nearly due north until it enters the main channel.

I have in former reports insisted upon the necessity of larger appropriations to insure a decided improvement of the channel between the jetties before the deterioration of Pumpkin Hill Channel should progress too far. The reopening of the old South Channel at the present juncture is fortunate, as from its greater distance from the jetties it may be comparatively more secure from their influence as long as operations remain suspended, but it is nevertheless true that efforts should be made to open the proposed new channel with superior depths as soon as practicable.

I stated in my last annual report that the funds set apart from the then available appropriation for dredging, about $28,000, could not be expected to produce very decisive results even in conjunction with the existing jetties, although it would doubtless have a tendency to secure better direction as well as a greater concentration of ebb currents through the new channel, but that the improvement that might be effected by dredging would be partially and perhaps wholly lost by the unavoidable suspension of operations. This anticipation has proved correct. The survey made in June last, six months after dredging had to be stopped, showed hardly a trace of the dredged cut, and only some increase of depth on the shallowest part of Swash Reef, where dredging had been done, could be recorded. I have no doubt that if funds had been available for continuing the work without intermission, very satisfactory results could have been reported at the end of the fiscal year.

Sullivan's Island.—The beach of Sullivan's Island has continued to wash down at and to the west of Bowman's Jetty, and some work of protection may be required here shortly. East of said jetty the beach has changed but little.

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* The Swash Channel is the one between the jetties.

Morris Island.—The cutting away of the north end of Morris Island has continued, and in a slighter degree the beach has washed down in the vicinity of the south jetty.

Mount Pleasant.—The two spurs built in 1884 for protecting that part of the shore-line of Mount Pleasant situated southeast of the ferry-boat wharf are in good condition. Sand has collected at their inner ends. No marked change in the high-water line has been observed, but at some points the bluff is still caving.

Inner Harbor.—No examination was made of Hog Island Channel during the past fiscal year. As I stated in my last annual report, its inner end or entrance has constantly increased in width for more than sixty years, and as the increasing volume of water diverted toward the channel cannot fail to have a detrimental influence upon the deep-water area in front of the city wharves, while it is probably the cause of the encroachment upon the shore-line of Mount Pleasant, it is desirable that suitable works should be built to prevent further enlargement of the entrance. I do not recommend, however, the diversion for that purpose of any funds which may be appropriated for improving the entrance of the harbor.

During the cyclone of August 25, 1885, a bark, which had been wrecked a year before at the mouth of the Ship-Yard Creek where it enters Town Creek, near the upper end of the city of Charleston, was drifted into a position to obstruct the channel of navigation in that creek. The Department authorized the removal of the wreck, in accordance with the provisions of section 4 of the river and harbor act of June 14, 1880. Proposals for doing this were advertised for and received, but were rejected on account of the excessive prices asked; and under authority of the Department the work was successfully and economically performed by the use of the United States snag-boat Toccoa, which was put in commission temporarily for the purpose. My report on the subject was forwarded to the Chief of Engineers under date of January 27, 1886.

With the funds next appropriated portions of both jetties will be raised to greater heights, and the work of dredging between their seaward ends may be resumed if the appropriation is adequate for both purposes.

This work is located in the collection district of Charleston, S. C., at the port of entry. Amount of duties collected in the calendar year 1885, $32,741.68.

Since the existing plan of improvement was adopted the following appropriations have been made:

By act of Congress approved June 18, 1878	$200,000
By act of Congress approved March 3, 1879	200,000
By act of Congress approved June 14, 1880	170,000
By act of Congress approved March 3, 1881	175,000
By act of Congress passed August 2, 1882	300,000
By act of Congress approved July 5, 1884	250,000
Total	1,295,000

Of this amount there has been expended from the beginning of operations to June 30, 1886, the aggregate sum of $1,294,945.

Balance yet to be appropriated on the original maximum estimate $1,712,500.

The following drawings and papers accompany this report:

Sheet I. Chart showing the sites of the north and south jetties, the progress made in their construction to June 30, 1886, and the present depths on the bar.

Sheet II. Showing section of the north jetty and a plan of the mattress at various points as built to June 30, 1886.

Sheet III. Showing section of the south jetty and a plan of the mattress at various points as built to June 30, 1886.

Report of First Lieut. Frederic V. Abbot, Corps of Engineers.

Table of commercial statistics furnished by the collector of the port.

Money statement.

July 1, 1885, amount available		$97,267 92
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$97,156 73	
July 1, 1886, outstanding liabilities	56 19	
		97,212 92
July 1, 1886, amount available		55 00
Amount appropriated by act approved August 5, 1886		187,500 00
Amount available for fiscal year ending June 30, 1887		187,555 00
Amount (estimated) required for completion of existing project		1,525,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		750,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

REPORT OF LIEUTENANT FREDERIC V. ABBOT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., July 1, 1886.

SIR: I have the honor to submit the following report of operations during the fiscal year ending June 30, 1886, for improving the harbor at Charleston, S. C.

Work on the first course south jetty was suspended on July 7, one mattress, 108 feet wide, having been placed, extending the foundation of the jetty 43 feet. The plant was transferred to the north jetty, and between July 8 and August 15, 2,030 linear feet of second-course mattresses, 55 feet wide, were placed on that jetty extending seaward from a point 11,090 feet from the shore-end.

Work was begun on August 21 on the south jetty, third-course mattresses, 44 feet wide and extending 1,206 feet seaward from a point 7,986 feet from the shore end, being used. This work was completed on October 15, 1885.

As no new appropriation had been made for continuing the improvements here, and as it was considered desirable to hasten results as much as possible, the experiment of depositing stone along the center lines of the jetties, with as steep slopes as it would take, was tried. About 5,000 cubic yards of stone were thus placed on the south jetty between points 7,986 feet and 14,025 feet from shore, and 4,000 cubic yards on the north jetty between points 9,193 feet and 13,687 feet from the shore end.

The stone was sufficient in quantity to have formed a ridge about 5 feet high on both jetties if the side slopes had been 1 on 1, but it was of course impossible to deposit it with anything like the regularity necessary to raise the jetty to this amount. The idea in doing this work was that the ridge would be soon leveled off by the waves, but that even then the stone would raise the jetty more than if it were originally distributed over the entire width of the mattresses. Nothing was lost by this method as it was only applied where the jetties were already so near low-water level as to render the further use of mattresses out of the question. When the time comes to raise the jetties, stone can be deposited as well where the remains of the ridge work exist as elsewhere.

As stated last year, the contractors deserve great credit for the faithful and skillful way in which they have done their work. The smallness of the sum available made it frequently necessary to shift the points at which work was in progress, so that the most could be accomplished with the limited means. This considerably increased their expenses for markers, &c.

On June 30, 1886, the total length of the foundation course of the north jetty was 14,327 feet; that of the south jetty was 16,440 feet. The sea end of the former was 1,200 feet, that of the latter 2,500 feet inside of the outer 18-foot curve, these distances being measured on the prolongations of the axes of the two jetties.

The dredge worked from the beginning of the year till December 31, 1885, at which time the allotment for that class of work was exhausted; 76,620 cubic yards of sand

and small shells were removed, and a cut, having a width of 75 feet and a depth throughout of not less than 11 feet, was obtained across Swash Reef. The shoalest sounding on this line before dredging began was 7.7 feet. The survey made in June, six months after dredging stopped, shows hardly a trace of anything like a dredged cut, although the shoalest sounding on this line is now 9.3 feet. Even while the cut was being dredged its side slopes were extremely flat, not steeper than 1 on 50.

The experiment may then be fairly said to prove that material can be removed from between the jetties effectively, and for a reasonable cost, by pump dredging, but that the jetties are not yet high enough to maintain a small cut. It is impossible to say what might have been the effect of a cut, say, 600 feet wide and 18 feet deep, as this would of itself have materially changed the currents between the jetties. Small expenditures for dredging are not at present economical, and the experiment on a large scale is too hazardous when experience with dredging on ocean bars elsewhere is considered.

On August 25, 1885, a cyclone destroyed most of the wharves and unroofed many houses in this city. A careful examination fails to show that any injury was done to the jetties. The unusual height to which the tide rose during the worst of the storm undoubtedly lessened the effect of the waves upon them. As soon after as the Government launch could be gotten afloat a survey was made of the jetty channel. No unusual changes were developed.

The annual survey has been made from a row-boat, and the area covered is more closely sounded than in any previous year. About 9,000 soundings were taken and over 7,000 were plotted to determine the several contours.

The ridge work on the center lines made it impossible to construct the longitudinal profiles of the jetties by running a number of lines over them from end to end as had been done in previous years. The method adopted was to make cross-sections, beginning about 300 feet on one side and rowing across the jetty, as nearly at right angles to its axis as possible, continuing the line at least 300 feet beyond the jetty. In this way much valuable information was obtained, not only as to the height of the crest of the jetties but also as to the condition of the bottom adjacent to them. It was found very difficult to make the boat move slowly enough to get more than a few soundings in each cross-section on the jetty itself, as both wind and strong tidal currents oblique to the desired direction of the section were to be overcome; but so many sections were taken (54 on the north and 72 on the south jetty) that the general condition of the structure is better known this year than ever before. Where ridge work had been done a large number of soundings near the center lines of both jetties were made with a pole so as to determine as well as possible the general shape and the least depth to be found on the ridge.

CONDITION OF NORTH JETTY.

The cross-sections showed that on a part of Drunken Dick Shoal the whole bottom has risen so that the jetty is nearly buried in sand. In places scour has occurred on both sides of the jetty unaccompanied by any perceptible settlement of the structure. At the point on Drunken Dick where settlement was reported in previous years, only one line shows any settling during the past year. As the soundings in that line were 60 feet apart, it is quite possible that we missed the highest part of the jetty entirely. At the extreme outer end there has been a general deepening of the bottom, not only in the vicinity of the jetty, and the latter appears to have been a good deal broken up, although it still shows as a sort of mound. The best examination that I could make with the money available shows that the ridge work does not average over 2 feet in height, but that in places it is 3 feet high.

CONDITION OF SOUTH JETTY.

The extreme inner end settled about 2 feet during the cyclone of August 25. Considerable stone was washed entirely off the jetty to the northward. On some portions of the jetty where no work has been done during the year the present longitudinal profile shows more jetty than was shown last year. This comes from the fact that the present profile has been constructed from cross-sections some distance apart. About 1,000 feet of the inner end show scour to the north of the jetty, due to the overpour of the strong flood tide along the shore of Morris Island. No settlement has occurred. Between points 7,000 and 9,000 feet from the inner end of the jetty the same action has occurred to a very marked degree on the south side. The maximum cutting has been 13 feet below the original bottom, the trench in that case being about 250 feet wide. No change has occurred north of the jetty at this part. No settlement has been detected by careful examination. At this point the ebb tide is very strong, and crosses the jetty nearly at right angles.

The outer 2,000 feet of the jetty has settled from 1 to 3 feet with no trace of scour due to over-pour. As this part was built on the crest of a shoal, its settlement is to be expected for a time. The extreme outer end has settled more, as it was in breakers and was not very heavily loaded with stone; it is probably badly broken up. The cross-sections here were too far apart to give a basis for very exact statements as to quantities.

At extreme low water some of the outer part of the jetty projects above water. The stone appears rather thin, but does not show any signs of being piled up more on one side of the jetty than the other. No large shell-fish have grown on the stones, nor even barnacles, unless perhaps very small ones. Logs are sticking up in places at considerable angles. They appear worm-eaten.

SWASH CHANNEL.

Jim Evans Shoal, as defined by the 9-foot curve, has not changed materially in size. The portion nearest to the north jetty has been considerably narrowed and pushed along parallel to the jetty. The shoal has extended somewhat towards the south jetty. Swash Reef, as defined by the 9-foot curve, has been reduced about one-half. The area above this curve was—

	Square feet.
In 1884	1,550,000
In 1885	1,000,000
In 1886	525,000.

The curve as a whole has moved south. The "inner pocket" has retired.

The channel which passes south of Jim Evans Shoal and north of Swash Reef has shoaled slightly in the part between Jim Evans and the south jetty. It has deepened in the part to the west of Swash Reef and shoaled in the part next to the north jetty.

The shoal water defined by the 12-foot curve has considerably increased during the year. The outer curves had all advanced somewhat seaward, the greatest change being generally in their southern portions.

PUMPKIN HILL, SOUTH, AND BEACH CHANNELS.

I have made no examination of either of these channels. The Coast and Geodetic Survey made a survey, including Pumpkin Hill Channel and the bar to the south of it. I am unofficially informed by the chief of the party that a good channel was found to the south of Pumpkin Hill and east of South Channel.

SULLIVAN'S ISLAND.

The cutting at and to the west of the Bowman jetty has continued. The rest of the beach has changed but little.

MORRIS ISLAND.

The cutting away of the head of the island has continued; it is less near the South jetty. No survey has been made to determine its exact amount.

HOG ISLAND CHANNEL.

No examination of this channel has been made.

MOUNT PLEASANT SHORE.

The spurs built in 1884 to stop the erosion of this shore are in excellent condition. Near their inner ends the sand has collected. There is no marked change in the high-water line, although the bluff continues to cave in places.

Mr. James P. Allen, assistant engineer, has rendered most valuable and efficient service during the past year, and it is with the most sincere regret that I have parted with him on account of the lack of funds to continue work.

Very respectfully, your obedient servant,

FREDERIC V. ABBOT,
First Lieutenant, Corps of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels, and commerce at Charleston, S. C., from January 1, 1875, *to December* 31, 1885.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	Vessels.	Tonnage.	Crew.	Vessels.	Tonnage.	Crew.	Vessels.	Tonnage.	Crew.	Vessels.	Tonnage.	Crew.
1875	504	382,018	11,949	38	13,144	326	198	88,879	2,404	740	484,041	14,679
1876	471	340,439	10,113	44	11,898	335	224	101,272	2,768	739	453,609	13,216
1877	400	324,919	9,885	32	13,972	308	236	105,480	2,851	668	444,371	13,044
1878	396	322,527	9,623	44	19,935	455	329	163,368	3,967	772	505,830	14,045
1879	383	326,681	10,027	39	12,505	319	246	121,503	3,292	668	460,689	13,638
1880	441	388,026	10,641	38	12,412	327	191	110,771	2,595	670	511,209	13,563
1881	412	399,732	10,377	34	9,430	272	257	121,077	3,073	703	530,239	13,722
1882	410	384,690	9,446	35	4,807	224	200	105,647	2,648	645	495,144	12,318
1883	345	277,538	7,629	26	3,002	157	239	113,768	2,958	610	394,308	10,744
1884	425	304,382	9,822	21	3,910	145	214	134,076	3,269	690	442,368	13,236
1885	375	268,477	9,637	15	2,344	97	187	106,233	2,586	577	377,054	12,320

CLEARED.

Year.	Coastwise Vessels.	Coastwise Tonnage.	Coastwise Crew.	American vessels Vessels.	American vessels Tonnage.	American vessels Crew.	Foreign vessels Vessels.	Foreign vessels Tonnage.	Foreign vessels Crew.	Total Vessels.	Total Tonnage.	Total Crew.
1875	461	328,266	10,830	57	24,679	555	211	94,595	2,527	729	447,540	13,912
1876	431	278,744	9,095	60	23,598	546	230	103,276	2,812	721	405,618	12,453
1877	335	234,429	7,719	85	22,767	423	250	108,446	2,910	620	365,662	11,052
1878	266	172,988	5,801	45	24,397	479	198	149,975	3,591	509	347,360	14,045
1879	287	188,212	6,268	34	11,282	292	278	149,052	3,648	599	348,546	10,208
1880	296	190,733	6,348	45	23,210	481	246	155,768	3,375	587	369,711	10.204
1881	268	187,569	5,942	32	9,239	255	278	153,796	3,464	578	350,604	9,661
1882	147	113,699	3,690	40	7,375	278	263	158,250	3,584	450	279,324	7,547
1883	98	48,714	2,018	27	4,560	181	299	154,653	3,815	424	207,927	6,014
1884	212	116,020	4,555	31	7,845	217	276	161,588	3,727	519	285,453	8,499
1885	191	99,658	5,047	24	5,217	164	204	119,602	2,836	419	224,467	8,047

COMMERCE.

Year.	Value of exports.	Value of imports.	Duties collected.
1875	$19,655,966	$680,348	$80,656 00
1876	18,088,152	455,562	89,168 00
1877	16,917,492	161,237	46,848 00
1878	21,167,575	184,127	36,990 00
1879	18,693,126	127,981	24,070 00
1880	24,939,259	248,158	46,453 98
1881	21,927,269	713,049	99,066 22
1882	19,907,099	459,970	45,263 33
1883	20,144,365	467,648	48,760 69
1884	20,833,424	508,504	36,624 76
1885	15,157,889	588,191	82,741 68

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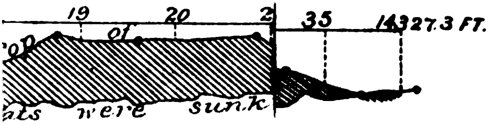

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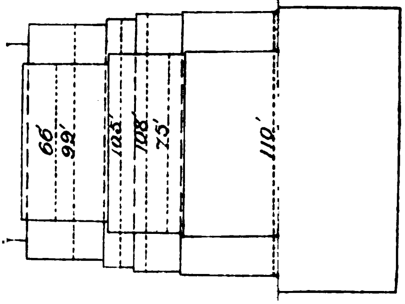

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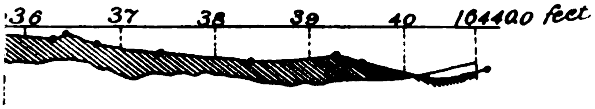
164400 feet

Arrivals and clearances of vessels, and commerce at Charleston, S. C., from January 1, 1885, *to December* 31, 1885.

ARRIVED.

	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
Entered through custom-house	375	268,477	9,637	15	2,344	97	187	106,233	2,586	577	377,054	12,320
No. entered through custom-house	540	284,729	......	..	......	......	...	....	......	540	284,729	......
Total	915	553,206	9,637	15	2,344	97	187	106,233	2,586	1,117	661,783	12,320

CLEARED.

	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
Through custom-house	191	99,658	5,047	24	5,207	164	204	119,602	2,836	419	224,467	8,047
Not through custom-house	684	427,540	......	...	......	......	...	....	......	684	427,540	......
Total	875	527,198	5,047	24	5,207	164	204	119,602	2,836	1,103	652,007	8,047

THEO. D. JEWEY,
Collector.

M 2.

IMPROVEMENT OF WAPPOO CUT, SOUTH CAROLINA.

The work of improving Wappoo Cut, South Carolina, with funds supplied by the General Government, was begun in November, 1882.

Three appropriations have thus far been made for it by Congress, aggregating $23,000.

Wappoo Cut is a narrow, tortuous, tidal stream, separating James Island from the mainland and connecting Stono and Ashley rivers. An examination of the creek was made under my direction some years ago, the report of which with project of improvement forms part of Appendix J 4, Annual Report of the Chief of Engineers for 1881, and is printed as House Ex. Doc. No. 19, Forty-sixth Congress, third session.

The project of improvement contemplates the establishment of a straighter channel of 6 feet depth and 90 feet width at mean low water, and comprises the following details of work:

1. Dredging on the bar at the entrance into Ashley River;
2. A solid cut through the marsh at the end of the first easterly reach, 2½ miles from Ashley River;
3. Dredging in Elliott's Cut and the reach leading to it, and on the bar at the outlet into Stono River;
4. Closing by a light bulkhead the three tidal streams that enter this new route from the north;
5. Building a jetty at the Ashley entrance to guide the flood-tide into Wappoo Cut; and
6. Building a jetty at the Stono entrance to guide the ebb tide into the cut.

The aggregate cost of these works was estimated at $34,000.

The mean rise and fall of the tides in Wappoo Cut is about 5 feet.

The delays in providing funds for carrying on the work, and the small amounts appropriated, have rendered it impossible to complete the work at every point. The unfinished cuts are therefore partially filled up from caving banks during the unavoidable and prolonged suspension of operations. A considerable increase in the total ultimate cost of the improvement is therefore unavoidable.

OPERATIONS PREVIOUS TO JULY 1, 1885.

The work consisted chiefly in dredging. Elliott's Cut was improved through its entire length of about 2,000 feet by establishing a low-water depth of 6 feet, on an average width of 60 feet. A solid cut 800 feet long, with an average width of 80 feet and a mean low-water depth of 6 feet, was made through the marsh of "Devil's Elbow," securing a straight and convenient passage in place of the extremely tortuous route through the bend bearing that name, which from end to end has a length of about 6,000 feet. A channel of the same depth was dredged through the shallow bends from Elliott's Cut to the Marsh Cut. Some dredging was also done on the bar at the Ashley River entrance to the cut.

In these operations 101,956 cubic yards of sand and mud were removed, together with a number of snags, stumps, and overhanging trees.

A bulkhead was built across the mouth of Pompey's Cut, a tidal branch entering Wappoo Cut at the upper end of Elliott's Cut, which had heretofore carried sand and mud into the navigable channel.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

On July 1, 1885, the sum of $3,027.84 was available for continuing the work of improvement. Proposals for dredging had been invited January 5, 1885, but none were received. In December, 1885, proposals were again invited, and two bids were received. With the approval of the Department a contract was awarded to Messrs. Ross & Sanford, of Jersey City, N. J., the lowest bidders, at the prices stated in the abstract of proposals appended hereto.

Previous to beginning operations under this contract a resurvey of Wappoo Cut was made from Elliott's Cut to Devil's Elbow, to determine where the funds available could be expended to the best advantage.

The low-water depth of 6 feet contemplated in the project and secured in the adopted line of channel by work previously done was found to have been maintained except near Pompey's Cut, where, at two reaches, aggregating about 300 feet in length, it had been reduced to from 4½ to 5½ feet by the sloughing of the sides of the channel. The width of 90 feet required by the project had not been established by the previous operations at the termination of which it had varied from 60 to 80 feet. The resurvey proved that these widths had been reduced more or less at several points by the caving in of the mud banks of the channel, especially in the bends between Pompey's Cut and the solid Marsh Cut.

It was therefore decided to put the dredge to work to restore the cut to its former dimensions, and, if possible, to widen it in accordance with the project.

Work under the contract was commenced in April and completed on June 19, following. Fifteen thousand and fifty cubic yards of sand, mud, and broken shells were removed and dumped, at distances of from 1 to 2 miles, in Stono River.

CONDITION OF THE WORK.

The improved reaches in Wappoo Cut are in a satisfactory condition. The shoals which had formed just eastward of Elliott's Cut have been removed, and navigation correspondingly benefited.

A least low-water depth of 5½ to 6 feet exists, except at a small bar at the Stono mouth of Elliott's Cut, which should be removed when a new appropriation is made.

The commercial value of Wappoo Cut as a sheltered inland route for the transportation of the products of a considerable area of country south of Charleston has been referred to in former annual reports. The accompanying report of my assistant, First Lieut. Frederic V. Abbot, Corps of Engineers, contains a few statistics showing the traffic which passed through Wappoo Cut during the past year.

When additional funds are provided, the bar at the mouth of Elliott's Cut will be removed and such other work done in accordance with the existing project as a re-examination of the several reaches may show to be most important.

Since the approval of the project for this improvement the following appropriations have been made:

By act of Congress approved March 3, 1881	$10,000
By act of Congress passed August 2, 1882	10,000
By act of Congress approved July 5, 1884	3,000
Total	23,000

The total expenditures to June 30, 1886, were $22,968.40.

This work is located in the collection district of Charleston, S. C. Charleston is the nearest port of entry. Amount of duties on imports collected in 1885, $32,741.68.

The report of First Lieut. Frederic V. Abbot, Corps of Engineers, is transmitted herewith.

Money statement.

July 1, 1885, amount available	$3,027 84
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,996 24
July 1, 1886, amount available	31 60
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,031 60
Amount (estimated) required for completion of existing project	10,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for dredging in Wappoo Cut, South Carolina, opened December 23, 1885.

No.	Names of bidders.	Price per cubic yard for distance.			To commence.	To complete.
		Not exceeding one mile	More than one and not exceeding two miles.	Not exceeding three miles.		
1	Thomas Bogges, jr	26 cents	30 cents	35 cents		
2	Ross & Sanford	17 cents	19 cents	21 cents	Feb. 1, 1886	Apr. 1, 1886

Contract awarded to Ross & Sanford at the price stated.

REPORT OF LIEUTENANT FREDERIC V. ABBOT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Charleston, S. C., July 1, 1886.

SIR: I have the honor to submit the following report of work done for the improvement of Wappoo Cut, South Carolina, during the fiscal year ending June 30, 1886.

In the months of May and June, 1886, about 15,000 cubic yards of dredging was done in Wappoo Cut just eastward of Elliott's Cut. The shoals which had formed there have been removed and navigation considerably benefited. A small bar still remains near the Stono mouth of Elliott's Cut, and is the most troublesome obstruction at the present time. The funds were not sufficient for its removal after the other work was completed.

I am indebted to Mr. E. Willis, of this city, for the following statistics showing the traffic which passed through Wappoo Cut during the past year:

Phosphate rock (valued at $225,000)	tons..	50,000
Sea-island cotton	bags..	5,000
Rice	bushels..	185,000
Vegetables	crates..	96,000 to 100,000
Fertilizers	tons..	1,200
Lumber	feet..	7,000,000
Aggregate tonnage of tugs, steamers, flats, lighters and sailing vessels using this route	tons..	100,000

Very respectfully, your obedient servant,

FREDERIC V. ABBOT,
First Lieutenant of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

M 3.

IMPROVEMENT OF ASHLEY RIVER, SOUTH CAROLINA.

The aggregate sum of $4,500 has thus far been provided by Congress, in three different appropriations, for improving Ashley River, South Carolina. The first appropriation, $1,000, was made by the act approved June 14, 1880.

Ashley River was examined and partially surveyed, under my direction, under a provision of the act of March 3, 1872. My report, with project of improvement, is printed as Appendix S 8 of the Annual Report of the Chief of Engineers for 1873.

The plan of improvement recommended comprised:

1. The removal of a shoal or bar at a place known as Accabee, between 7 and 8 miles above Charleston City, where only 9 feet of water at mean low tide was found in 1873, while the channel of approach to it from below was only about 40 feet in width between the 10-foot curves.

2. The removal of a shoal at a point below the the Wando Phosphate Works, about 2 miles above Accabee, where only 6 feet of water was found at low tide.

It was proposed to lower these shoals by dredging to a low-water depth of from 10 to 11 feet.

The mean rise and fall of tides in Ashley River is about 5 feet.

The cost of the work was estimated at $5,000. To maintain the depths required under the foregoing plan, and obtained by means of the appropriations made, occasional dredging will have to be done during the next year, and the original estimate will, therefore, be somewhat exceeded. In order to render the improvement practically permanent, a revised or enlarged project would be required, providing for wing-dams or other suitable works to direct and concentrate the river currents over the shoal crossings. The principal traffic on Ashley River consists in the carrying to the city of Charleston the products of the mills of the several phosphate companies located above the shoals, but the necessity for incurring the expense of a more permanent and more costly improvement has not yet been urged or become apparent, and therefore no enlarged project has been presented or recommended.

OPERATIONS PREVIOUS TO JUNE 30, 1885.

Dredging was done during the month of February, 1882, at a point of the river known as "The Crossing," at the Wando Works. A channel of about 100 feet width and over 1,000 feet in length was cut through the shoal, separating the 11-foot low-water curves on either side, and a depth of 11 feet at low tide was established.

The cost of this work practically exhausted the funds then available.

A third appropriation of $2,000 having been made by the act approved July 5, 1884, proposals were invited for expending the amount in continuing the work. Only one bid was received, and this was rejected, the price asked, 30 cents per cubic yard, being deemed too high.

Nothing else was done except making some local surveys and examinations to select points where dredging would be needed and to ascertain the condition of the channel improved in 1882. It was found to have been satisfactorily maintained.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

In December, 1885, proposals for dredging were again invited, and of the two bids received, the lowest, that of Messrs. Ross & Sanford, was accepted, and the contract was awarded them at 20 cents per cubic yard.

The dredge was put to work at a shoal near the Stono Phosphate Works about 9 miles from the city of Charleston. The depth of the channel here averaged about 9 feet at mean low water. Operations were commenced in April and completed in the following month, 8,566 cubic yards of material having been excavated, forming a channel 11 feet deep and 210 feet wide at mean low water.

The funds next appropriated will be applied to enlarging the channels heretofore dredged, where necessary.

This improvement directly benefits the business of the several phosphate works located above the shoals referred to and thus, indirectly, the commerce of the city of Charleston. I am informed that in the year ending May 31, 1886, 140,597 tons of phosphate rock, valued at $646,000, were transported down the Ashley River.

This work is located in the collection district of Charleston, S. C. Charleston is the nearest port of entry. Amount of duties collected in 1885, $32,741.68.

Since the plan of improvement was adopted the following appropriations have been made:

By act of Congress approved June 14, 1880	$1,000
By act of Congress approved March 3, 1881	1,500
By act of Congress approved July 5, 1884	2,000
Total	4,500

The total expenditures to June 30, 1886, were $4,457.26.

Money statement.

July 1, 1885, amount available	$2,054 57
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,011 83
July 1, 1886, amount available	42 74
Amount appropriated by act approved August 5, 1886	1,000 00
Amount available for fiscal year ending June 30, 1887	1,042 74

Abstract of proposals for dredging in Ashley River, South Carolina, opened December 23 1885.

No.	Names of bidders.	Price per cubic yard.	To commence.	To complete.
		Cents.		
1	Thomas Bogges, jr	23		
2	Ross & Sanford	20	Feb. 1, 1886	Mar. 10, 1886

Contract awarded to Ross & Sanford at the price stated.

M 4.

IMPROVEMENT OF EDISTO RIVER, SOUTH CAROLINA.

By the river and harbor act passed August 2, 1882, the sum of $8,000 was appropriated for improving Edisto River, South Carolina. This was the first appropriation made by Congress for this work. By the act approved July 5, 1884, a second appropriation was made amounting to $5,000.

The Edisto is one of the principal rivers of South Carolina. It is formed by the junction of the North and South forks, which unite in the southern part of Orangeburg County. The South Fork, commonly known as the South Edisto, is the main river. It empties into the ocean near Saint Helena Sound.

Edisto River was examined under my direction with a view to its improvement in September and October, 1880. My report, dated December 31, 1880, with project of improvement, is printed as Appendix J 15 of the Annual Report of the Chief of Engineers for 1881, and also as part of House Ex. Doc. No. 23, Forty-sixth Congress, third session.

It is contemplated to improve the river from Guingard's Landing, in Aiken County, to the mouth, a total length of 260 miles, so as to establish a safe navigation at all seasons of the year for light-draught steamboats from the sea to the junction of North and South forks, near the crossing of the South Carolina Railroad, 183 miles from the mouth, and thence to Guingard's Landing for rafts and flat-boats. It is not deemed advisable to attempt an improvement of the reaches higher up which are excessively encumbered with logs and shoals.

The obstructions to navigation consist of numerous bends, logs, snags, overhanging trees, and piles, and also of shoals, composed generally of sand, but in some places of hard clay.

The project of improvement comprises the following details of work:

(1) Enlargement and clearing of all the new channels now in process of formation.

(2) Forming new channels across necks of bends where needed.

(3) Shutting off lateral arms which now weaken the stream.

(4) Removal of logs, snags, and pile obstructions.

(5) Removal of shoals of sand and clay in one case by building a deflecting jetty.

The total cost of the project was estimated at $33,385.

At the present time there exists no reason for augmenting this original estimate.

Nothing was done during the past fiscal year, as the balance on hand July 1, 1885 ($370.14), could not be expended advantageously.

OPERATIONS PREVIOUS TO JUNE 30, 1885.

The work of improving Edisto River has been performed partly by the United States snag-boat Toccoa and partly by hired labor.

Pile obstructions placed in the channel of the river during the late civil war at Willtown, 30 miles from the mouth of the river, at Ash Creek, a short distance above and near the Charleston and Savannah Railroad Bridge at Jacksonborough, 39 miles from the river's mouth, were removed. A narrow cut-off known as the "Suck" at Norman's Landing, 50 miles above Jacksonborough, was widened and deepened and made the regular channel for navigation.

Fragments of the wreck of a steamboat, forming a serious obstruction near Willtown, were also removed. From the mouth of the Edisto to Kennedy's Bridge, a distance by river of 130 miles, 11,223 logs, snags, and overhanging trees, varying from 12 to 72 inches in diameter, were removed, in many cases requiring the use of dynamite. Numerous outlets into the swamps forming the banks of the river were closed, as well as several of those incipient natural cut-offs, known as "sucks" from their tendency to draw log rafts against the banks at their upper ends where these rafts frequently stranded and had to be abandoned. Banks were trimmed at numerous places.

This work was not performed by contract, because from its nature no proposals could be made without an excessive margin for contingencies.

The raft navigation of the Edisto on the reaches where operations were carried on has undoubtedly been greatly improved. Lumbermen state that the time of transit of timber and lumber from mill to market is now materially less than formerly.

There are at present no steamboats plying on the river, and until the projected improvements are completed such boats, if exceeding 80 feet in length and 2 feet draught when loaded, cannot ascend to Friendly's Ferry, 63 miles above Jacksonborough; and it is not probable that boats of that capacity with the freight suited to them and afforded by the locality, viz, shingles, staves, resin, turpentine, &c., could profitably compete with the South Carolina and the Charleston and Savannah railroads, which traverse the Edisto in this section of the State. Small steamers carrying no freight, with sufficient power to tow a number of flat boats may in future be employed with advantage.

I am informed that the lumber shipped lately has generally been of comparatively low grade, which is ascribed to the fact that the long-leafed yellow pine has been cut from near the river for many miles up, and can now be found only by going from 6 to 12 miles back. It is thought that when the improvement shall have been completed to Guingard's Landing, 77 miles above the junction of the South and North

Edisto, in accordance with the existing project, and still more if the last-named branch of the river were more or less cleared and straightened, as appears to be urgently desired by the parties engaged in the lumber trade on the banks of that tributary and its affluents, large areas of valuable pine and hard-wood land will be brought within reach of the axman. The products of the mills can be sent to market more cheaply as stronger currents favoring the movement of rafts will be developed, and the swamps, being drained by the more rapid flow of water in the river-bed proper, timber standing back from the banks will become accessible.

Parties directly interested in the traffic on the Edisto state that during the past year between 45,000,000 and 50,000,000 feet of timber were shipped at a cost 25 per cent. less than four years ago, which saving is to a large extent attributable to the improvements thus far made by the Government. It is further stated that about 4,400,000,000 feet of standing timber are tributary to this river, and that the mill owners and timber men are gratified at being able to reach their markets with greater ease and safety than formerly.

I respectfully repeat my recommendation of last year, that the necessary appropriation be made to complete the improvement of the river in conformity to the approved project.

The additional amount required for the purpose is $20,385.

Since the present project of improvement was adopted the following appropriations have been made:

By act of Congress passed August 2, 1882	$8,000
By act of Congress approved July 5, 1884	5,000
Total	13,000

The total expenditures to June 30, 1886, were $12,719.33.

This improvement is located in the collection district of Charleston, S. C. Charleston and Beaufort, S. C., and Savannah, Ga., are the nearest ports of entry.

Duties on imports collected at the custom-house of Charleston, S. C., in 1885, $32,741.68.

Money statement.

July 1, 1885, amount available	$370 14
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	89 47
July 1, 1886, amount available	280 67
Amount appropriated by act approved August 5, 1886	3,000 00
Amount available for fiscal year ending June 30, 1887	3,280 67
Amount (estimated) required for completion of existing project	17,385 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

M 5.

IMPROVEMENT OF SALKIEHATCHIE RIVER, SOUTH CAROLINA.

Two appropriations have thus far been made by Congress for improving Salkiehatchie River, South Carolina, aggregating $8,000.

The river was examined under my direction during the latter part of 1880, and my report of the examination, dated December 29, 1880, is printed as Appendix J 16, Annual Report of the Chief of Engineers for 1881, and as part of House Ex. Doc. No. 23, Forty-sixth Congress, third session.

The Salkiehatchie River, also named the Big Salkiehatchie to distinguish it from one of its tributaries, known as the Little Salkiehatchie, rises in Aiken County, South Carolina. These two rivers unite about 80 miles from the Atlantic seaboard. About 24 miles below the junction the Salkiehatchie is spanned by the Charleston and Savannah Railroad Bridge. Further down the river is known as the Combahee, which discharges into Saint Helena Sound about midway between the cities of Charleston and Savannah.

The mean rise and fall of tides in Saint Helena Sound is 5.9 feet. At the railroad crossing, nearly 60 miles from the river's mouth, it is 2.5 feet, and the tidal oscillation reaches a point about 20 miles higher up.

PROJECT OF IMPROVEMENT.

The project contemplates the creation of a continuous and practicable channel for rafts and flat-boats in the lower reaches of the river from a point 5 miles above Toby's Bluff down to Hickory Hill, 12 miles below the railroad bridge, and 46 miles above the river mouth, comprising a total length of river of 77 miles.

The work would comprise the removal of piles at Hickory Hill, and the removal of logs and of the shoals accumulated around them in the reaches above the bridge.

Through Murdock's and Weekly Sand Drags, where the Salkiehatchie divides into numerous insignificent streamlets, cuttings must be made to form a channel of sufficient dimensions for rafts and flat-boats. The cost of this improvement is estimated at $18,000. It is believed that the original estimate will not be exceeded.

OPERATIONS PREVIOUS TO JUNE 30, 1885.

The United States snag-boat Toccoa removed 16 piles to clear the channel at Hickory Hill, which had been obstructed during the late civil war; also 106 stumps, snags, and overhanging trees between that point and the railroad bridge. The operations of the boat were confined to this section of the river, the bridge preventing it from proceeding higher up.

Above the railroad bridge operations were carried on by hired labor, the work being of such a miscellaneous nature as to preclude its being done by contract without allowing an excessive margin for contingencies.

From the bridge to the Forks, a distance of 21 miles, the river was thoroughly cleared of obstructions. Higher up, between the Forks and Braxton's Ford, a reach of 59 miles, a large amount of work was done to improve raft navigation, by removing obstructions, straightening the bed of the river, and by shutting off lateral channels.

The number of snags, stumps, logs, and overhanging trees taken from the channel and banks of the river aggregated 11,240; more than a hundred outlets were closed; two shoals or islands were removed; twenty-six mud and sand points were cut off, and the banks were trimmed in numerous places.

No work was done during the fiscal year ending June 30, 1886.

CONDITION OF THE RIVER AND EFFECTS OF THE WORK DONE.

All the reaches where improvements have been made have remained in the same condition, substantially, in which they were left when work was suspended in May, 1885. Raft navigation has been materially benefited by the work done. I am informed that the cost of transporting timber down the Salkiehatchie is now from 33 to 50 per cent. less than formerly on account of the improvements made by the Government.

In view of the favorable results heretofore obtained it is recommended that the funds necessary for completing the existing project be supplied. An additional appropriation of $10,000 is needed for the purpose.

Since the adoption of the present plan of improvement the following appropriations have been made:

By act of Congress passed August 2, 1882	$5,000
By act of Congress approved July 5, 1884	3,000
Total	8,000

The total expenditures to June 30, 1886, were $7,924.17.

This work is located in the collection district of Charleston, S. C. Beaufort is the nearest port of entry.

Money statement.

July 1, 1885, amount available	$141 10
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	65 27
July 1, 1886, amount available	75 83
Amount appropriated by act approved August 5, 1886	2,000 00
Amount available for fiscal year ending June 30, 1887	2,075 83
Amount (estimated) required for completion of existing project	8,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	8,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

M 6.

IMPROVEMENT OF SAVANNAH HARBOR AND RIVER, GEORGIA.

Operations for improving Savannah Harbor and River, Georgia, during the past fiscal year were conducted in conformity with the enlarged project based upon an examination made in compliance with section 3 of the river and harbor act, approved March 3, 1881. It was provided in that section that an examination or survey, or both, with estimates of cost of improvement proper should be made in the Savannah River to increase the depth of water in said river and harbor, from the bar up to the city, to 22 feet, and to make an estimate of the cost of widening the channel of the Savannah River opposite the city to 600 feet, of uniform depth with the balance of the channel.

My report of this examination, dated January 16, 1882, is found in the Annual Report of the Chief of Engineers, 1882, as part of Appendix J 4, and is printed as Senate Ex. Doc. No. 19, Forty-seventh Congress, first session.

During the two years preceding the autumn of 1873, Congress had appropriated the aggregate sum of $100,000 for improving the river below the city of Savannah, which was expended mainly in removing wrecks, cribs, and other obstructions.

By act approved February 27, 1874, the sum of $193,132.96 was appropriated for the relief of Mr. Henry S. Wells for work done by him in removing wrecks, cribs, &c., under contracts with the Treasury Department of May 1 and July 5, 1886.

PLAN OF IMPROVEMENT.

The project under which operations have lately been carried on is an enlargement of two previous projects, dated August 28, 1873, and March 19, 1879, respectively. These two projects embraced the following general details of work:

Widening the water-way at the city front.

Deepening, widening, and straightening the channel by dredging at various points below the city to the vicinity of Tybee Roads.

A dam at the Cross Tides, 4 miles above the city.

A short bulkhead on the Hutchinson Island side, opposite the upper part of the city.

Adopting the north channel of the Savannah River for final improvement, in preference to the south channel, from the head of Elba Island, to the head of Long Island, which required the construction of a low dam across the upper end of the south channel, closing the lateral channels connecting the north channel with the south channel, from Elba Island to Cockspur Island, and some shore protection. Such land along the water front on Hutchinson's Island and Fig Island, opposite the city of Savannah, as might be needed in widening the channel-way at these localities was to be purchased.

The enlarged project embraced in my report of January 16, 1882, comprised in substance the features of the two previous plans, and provided in addition for a number of works, chiefly wing-dams, that are considered to be necessary for the further improvement of the channel of navigation from Tybee Roads to the city of Savannah, with a view of rendering the improvement practically permanent. For the details of this project I beg leave to refer to my annual report for the year ending June 30, 1882.

The total cost of the improvement according to the enlarged project of January 16, 1882, was estimated at $730,000, in addition to the sum of $482,000 appropriated previous to that date.

OPERATIONS PREVIOUS TO JUNE 30, 1885.

At Cross Tides, 4 miles above the city of Savannah, a dam was constructed, formed of brush mattresses and riprap-stone. It is designed to reduce the volume of water diverted down Back River and to increase the ebb flow in Front River past the city front where it is most needed for navigation. The work crosses the arm connecting Front and Back River and extends from Argyle Island to Hutchinson's Island, joining the rice dikes at either end. The low-water width of the river is here 750 feet; the whole length of the dam, from dike to dike, 1,025 feet.

This structure was commenced in December, 1878. In June, 1882, it had reached a height of 3 feet above the level of mean low water, but considerable settlement subsequently occurred at points where the overpour of water produced damaging scour. To secure the stability of the work an apron of log mattresses, loaded with broken stone, was placed along its base and the dam was raised to the level of mean high water by the use of brush fascines and riprap-stone.

About 70 linear feet of the old King's Island crib jetty, near the cross-tides, was removed to facilitate the flow of water into Front River.

Between King's Island and Hutchinson's Island and lower down the Front River (or Savannah River proper) to the city of Savannah, sand and mud aggregating about 96,500 cubic yards were removed by dredging to aid the inflow of the tide.

Dredging to an aggregate amount of 279,087 cubic yards was done in front of the city to increase the depth of water on Garden Bank Shoal and to widen the river to 660 feet by cutting off the projecting point of Fig Island opposite the wharves of the Savannah, Florida and Western Railroad.

Three wing-dams, composed of log mattresses and riprap-stone, were constructed opposite the lower part of the city in order to increase the strength of the currents by reducing the width and augmenting the depth of the water-way at Garden Bank Shoal. Their shore ends rest on Fig Island. They contract the water-way to about 660 feet; the width was formerly from 900 to 1,050 feet.

From 1876 to 1885 an aggregate of 598,393 cubic yards of material was removed by dredging from the new channel at "The Wrecks." Previously about 142,000 cubic yards had been removed from the old Fig Island Channel, the improvement of which was abandoned in 1875 as recommended in my letter to the Chief of Engineers, dated May 13, 1875.

A training-wall, known as Fig Island jetty, was built for a length of about 6,000 feet eastward, or down-stream, from a point a little above the lower end of Fig Island, with which it is connected by a return work 160 feet in length. The jetty runs about parallel to the right bank of the river; its down-stream end rests in 15 feet water at mean low tide. The work was built with alternate courses of log and brush mattresses and riprap-stone, and is provided on its channel side with eleven short spurs of similar construction placed at right angles to the axis of The Wrecks Channel. The heads of the spurs are so aligned that the low-water width of the water-way increases from 680 feet at the upper spur to 740 feet at the lowest.

The jetty was originally built up to a height of 2 or 3 feet above the level of mean low water, but the cross-currents producing scour and corresponding settlement at various points, its crest was, for about two-thirds of its length, brought up with brush fascines and broken stone to 5 feet above the low-water level.

For better regulating the ebb flow from Front River into the channel at The Wrecks a spur jetty was built about 480 feet above the shore end of Fig Island Jetty.

Two dams, numbered 5 and 11½ respectively, were built to close lateral channels to the northwest and southeast of Barnwell's Island, opposite Fort Oglethorpe. They rise from 2 to 6 feet above the level of mean low water, and are designed to increase the flow of water in the main channel abreast of the head of Elba Island.

A submerged dam was constructed across the south channel of Savannah River a short distance below the head of Elba Island. By partially closing this branch it was designed to promote the ebb flow in the north channel, which is the one selected for improvement. The question of raising the crest of this dam to a higher level is held in abeyance.

A wing-dam (No. 15) extends eastward from a small mud island, named Barnwell's Island, No. 3, towards the upper end of Elba Island, reducing the width of the water-way, previously nearly 2,000 feet, to about half that width.

Three lateral channels, formerly connecting the north channel with the south channel, have been closed. One of the dams shuts off Philbrick's Cut, at the lower end of Elba Island; another, "Big Gap Dam," passes across the channel between Island One-and-Two and Bird Island, and the third closes the two channels between Bird and Long Island.

Considerable work was done toward improving the north channel from Elba Island to the mouth of the river, with a view of deepening the shallow reaches at different places where the water-ways were of excessive width. These shoals are found at the crossings where the navigable channel or main line of currents is deflected from one bank to the opposite one.

The first of these crossings, in going down the stream, is known as the Upper Flats. They extend from the lower end of Spirit Island to the deep water-way abreast of the middle and lower north shore of Elba Island. While in the deep water-way just above, between Spirit Island and the South Carolina shore, the widths of the Savannah River vary between 1,100 and 1,200 feet, they increase to over 4,000 feet in the middle portion of the reach occupied by the Upper Flats.

Three pairs of wing-dams were built here, those of each pair placed opposite to each other, leaving open a channel of the desired width between their heads. The first (upper) pair, Nos. 4 and 23, contract the water-way at the easterly end of the passage between Spirit Island and the main shore of South Carolina. The next pair (Nos. 6 and 25) is built 800 yards lower down; and about the same distance further down a third pair (Nos. 10 and 27) was constructed.

These dams rest with their inner ends upon the shores from which they spring, except No. 27, on the north side of the ship-channel, where a gap of about 500 yards width was left between dam and shore. The width of the water-way left open between the heads of the dams is 1,044 feet at the upper pair and 1,200 feet at the lower.

The next shallow crossing improved is named "Lower Flats," or Cabbage-Tree Crossing. This reach separates the deep pool at the lower end of Elba Island from the deep waters of the anchorage on the opposite shore, in the vicinity of Venus Point, Jones Island. At the upper end of this crossing the river has a width of over 2,400 feet; by the construction of a pair of wing-dams (Nos. 14 and 29) the water-way between them was reduced to 1,250 feet. At the lower end of the crossing a single wing-dam (No. 13) was placed, but not completed; its shore-end rests upon the lower end of Island One and Two; it leaves a passage of 1,250 feet between its head and the opposite shore of Jones Island.

The third crossing is named Long Island Crossing, a reach of deficient depth of water extending from the lower end of the anchorage grounds off Venus Point across the river to the deep waters abreast of the lower half of Long Island. For the improvement of this crossing wing-dams Nos. 26 and 33 were built; they reduce the original width of the water-way of 3,100 feet to 1,300 feet. These two works, at the close of the previous fiscal year, June 30, 1885, had settled in a few places from 4 to 6 feet.

At the mouth of the river the existing ship-channel passes between Cockspur Island, on the south, and the shoal known as Oyster Bed, partly bared at high water, on the north, the channel being located near the latter. There is a wide expanse of water to the north of Oyster Bed Shoal, between it and Turtle Island, for the greater part shallow, but quite deep near the shoal where the now abandoned northerly channel of entrance was located. As very strong ebb currents were observed to continue to set in that direction, diverting water to the detriment of the channel selected for improvement south of the Oyster Bed, a closing-dam (No. 31) was commenced in May, 1885. It is designed to extend it from a point on the westerly shore of the Oyster Bed, between the Quarantine Station and the Oyster Bed (red light) Beacon, northwest to a southerly point of Turtle Island. From that portion of the river known as "The Obstructions," at the head of Elba Island down to Tybee Knoll, northeast of Fort Pulaski, 551,255 cubic yards of material were removed by dredging prior to June 30, 1885.

In addition to the work described above, a number of wrecks of large vessels and fragments of wrecks, as well as piles and other obstructions placed in the river during the late civil war, were taken from the ship-channel.

It is estimated that from December, 1878, when work on the dams was commenced—at Cross Tides—to June 30, 1885, the following quantities of material have entered into the construction of wing-dams, closing-dams, and jetties:

Log and brush mattresses, averaging 18 inches in thickness, 280,111 square yards; brushwood fascines and brushwood mattresses, 18,230 cubic yards; riprap stone, 60,105 cubic yards.

The aggregate length of all kinds of dams built during the period mentioned was 29,320 feet, viz:

	Feet.
Closing-dam at Cross Tides	1,025
Wing-dams Nos. 1, 2, and 3, at Garden Bank Shoal	900
Wing-dam, Front River below Garden Bank Shoal	225
Fig Island Jetty (6,000 feet) with 11 spurs; total	7,600
Closing-dams Nos. 5 and 11½, Barnwell's Island	1,200
Submerged dam, South Channel	1,460
Wing-dam No. 15, below channel at The Obstructions	880
Three closing-dams (Philbrick's Cut, Big Gap, and Dutch Gap); total	3,250
Wing-dams Nos. 4, 6, 10, 23, 25, and 27, Upper Flats; total	5,080
Wing-dams Nos. 13, 14, and 29, Lower Flats; total	3,000
Wing-dams Nos. 26 and 33, Long Island Crossing; total	2,100
Closing-dam, Oyster Bed Shoal No 31	2,600
Total	29,320

On June 30, 1885, several of the above specified structures still required more or less additional work, some of them not having been completed according to the designs, and others requiring repairs. Wing-dam No. 13 had not yet reached the contemplated height, and closing dam No. 31 was unfinished, both as to height and length. Cross Tides Dam, Fig Island jetty, the closing dam at Philbrick's Cut, and some of the wing-dams at the Upper Flats had settled in places, and required to have their crests brought up to the proper level.

The total expenditures to June 30, 1885, for the works above described were $831,614.40.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

On July 1, 1885, a balance amounting to $50,385.60 was available for continuing the improvement.

Work upon the dams was continued and dredging was resumed under the existing contracts, the details of which were given in my last annual report.

The work of construction was confined chiefly to Dam No. 31, at Oyster Bed Shoal. That portion of the dam which occupied comparatively deep water, crossing the westerly end or entrance of the abandoned north channel and extending about 1,600 feet northwesterly from the shore end on the shoal, was raised to about the level of mean low water—an increase in height equal to 3 to 4 feet compared with the average elevation of the top of this part of the dam at the close of the previous fiscal year. The mean depth of the water at low tide along this section of the work while being laid was 9 feet, with maximum depth of 14 feet in the immediate vicinity of the Oyster Bed.

Cross Tides Dam, the central portion of which was washed out to the level of low water, was repaired during the first months of the fiscal year, and its crest raised to the level of high water. Other damages caused by a cyclone occurring on October 11, 1885, were likewise repaired, riprap-stone, taken from other dams where it could be temporarily spared without detriment, being used for the purpose.

The closure-dams at Philbrick's Cut and Big Gap, which had settled at some points, were again brought up to the level of mean high water, uniformly with the other portions of their respective crests.

The work of raising the crest of Fig Island jetty to a uniform height of about 5 feet above mean low tide was finished. Wing-dams Nos. 6, 25, and 27, which, as I stated in my last annual report, had settled at several points, had their sunken crests brought up with brush fascines and riprap-stone to an even level. Wing-dams Nos. 26 and 33, Long Island Crossing, which, as already stated, had settled somewhat, were in a similar manner raised to an even crest.

Operations under Mr. Gaynor's contract terminated September, 1885. From July 1, 1885, to the close of operations, 12,043 square yards of log-and-brush mattresses, 4,044 cubic yards of brushwood mattresses and fascines, and 4,526 cubic yards of riprap-stone were used in the work.

Between July 1 and October 6, 1885, when work under Mr. Ross' contract was closed, 38,474 cubic yards of sand and mud were dredged from the several reaches between the city of Savannah and the upper end of Long Island, a distance of 8½ miles. The amounts dredged from the several portions of the channel were as follows:

	Cubic yards.
From Garden Bank Shoal	4,954
From the channel at The Wrecks	20,531
From the channel at The Obstructions	3,134
From the channel at Upper Flats	1,688
From the channel at Lower Flats	8,167
Total	38,474

Surveys, &c.—Besides local surveys and examinations made during the progress of the above operations, a line of levels in connection with tide-gauge observations, extending from the Cross Tides to Fort Pulaski was commenced and completed.

Parties owning rice-lands upon the upper portion of Hutchinson's Island having preferred claims for damages thereto, alleged to have been caused by the elevation of the low-water level of Front River in consequence of the construction of the dam at Cross Tides, a series of tidal observations was made in the vicinity, and a special report on the subject was submitted to the Chief of Engineers under date of April 29, 1886.

CONDITION AND EFFECTS OF THE WORK.

Cross Tides Dam.—On June 30, 1885, the crest of this dam had been brought up to the level of mean high water. Unequal settlement and a cylone on October 11, 1885, caused slight local breaks, which were repaired. Lately two other breaks have occurred of an aggregate length of about 300 feet, lowering the crest to from 1 to 9 feet. This lowering is not due to settling alone; a great deal of stone is habitually thrown off the work by fishermen and others to secure a shorter route from Back River to the city of Savannah. It is also possible that the pressure of water at low tide, at which period since the practical completion of the dam, the water stands very nearly 3 feet higher on the up-stream than on the down-stream side, may have a damaging effect. The deep-water pockets above and below the dam, referred to in previous reports, have gained somewhat in depth during the past fiscal year.

In front of Savannah City.—Some shoaling has occurred during the year opposite West Broad street, but there is still a practicable channel of 21 feet depth, at mean high water. The channel at Garden Bank Shoal has also slightly shoaled; the least high-water sounding is now 19.4 feet. Much of the dredging periodically required at these places is rendered necessary by the large volumes of sand that are washed from the city streets into the stream at every rain-storm. The Garden Bank wing-dams are in good order.

Channel at The Wrecks.—The cyclone of August 25, 1885, did some damage to the Fig Island jetty, carrying off stone and brush at several points, but generally the dam has maintained its crest at the proper height. Silt continues to be deposited between the short spurs on the channel-side, as expected and desired.

The least practicable mean high-water depth in the channel at The Wrecks is now 21.1 feet, a gain of 1 foot during the year. Some shoaling occurs occasionally at the lower end of the channel. It is expected that this defect can be permanently remedied by an extension of Fig Island jetty and by some dredging.

Channel at The Obstructions.—The shoal at The Obstructions was lowered more than 1 foot during the year. The least available depth of the channel is at present 20.9 feet at mean high tide. As suggested in my last annual report, it is anticipated that the submerged dam near the entrance of and across the South Channel will have to be raised higher in order to increase the volume of ebb-flow over this shoal and keep it down by scour. Wing-dam No. 15, near the lower end of the channel, remains in good condition.

Upper Flats.—The improved mean high-water depth of 22 feet of the channel at the crossing has been well maintained, except at the lower end, between Wing-dams Nos. 10 and 27, where the depth is six-tenths of a foot less. The wing-dams built for improving this reach are in good order.

Lower Flats.—The channel here is at present 1 foot deeper than on June 30, 1885; its least mean high-water depth is now 21.5 feet. Wing-dams Nos. 14 and 29 were injured by the cyclone in August, 1885. No repairs could be made for want of funds. Dam No. 13 is still unfinished.

Long Island Crossing.—The two wing-dams, Nos. 26 and 33, built during the previous fiscal year, were damaged by the August cyclone; their crests were considerably lowered, from one to three courses of mattresses and riprap-stone having been carried away. It has not been possible to make any repairs. Probably, owing to the condition of these works, the channel of the crossing, which had already attained a mean high-water depth of 22 feet, has shoaled to some extent on a length of about 4,000 feet, where there is at present a minimum depth of from 20 to 20.5 feet. In order to re-establish the required depth of 22 feet it is deemed advisable not only to repair both wing-dams, but also to build a third one, projecting from a point near the eastern end of Jones Island, a work which is included in the enlarged project in my report of January 16, 1882.

Mouth of river.—Dam No. 31, at Oyster Bed Shoal, is still unfinished. It was seriously injured by the cyclone of August, 1885, but the damages were partially repaired. Its crest is almost uniformly at the level of mean low water. The channel southwest of Oyster Bed Beacon, which heretofore has always shown a tendency to shoal, has deepened 3 or 4 feet during the past year; it has now, everywhere, depths exceeding 22 feet at mean high water. This result may safely be ascribed to the effect of Dam No. 31, the completion of which will undoubtedly render the present favorable condition of the channel permanent.

Closing-dams.—The several existing closing-dams below the city of Savannah are all in good order. A small gap has been left in the dam at Philbrick's Cut and one in Big Gap Dam for the passage of small boats.

While it is regretted that for want of an appropriation in 1885 greater progress could not be made during the past fiscal year, it having been impracticable even to repair many of the damages caused by the storm in August last, it can, nevertheless, be stated that the river is in an excellent condition. During last year several vessels of over 20 feet draught have passed from the city to the sea and from the sea to the city, on a single tide. In one instance a vessel drawing 20 feet 9 inches was brought in. This had never been accomplished before. From the record of draughts appended to the accompanying report of my assistant, First Lieut. O. M. Carter, Corps of Engineers, it is seen that from 1872 to the present time the available depth in the navigable channel has increased 3 to 3.5 feet. As a matter of fact all this increase has taken place within the last five or six years, while the work of constructing wing-dams and closing-dams has been in progress.

The importance of the city of Savannah as a commercial port seems to have been amply recognized by Congress through liberal appropriations heretofore made for improving the river and harbor. In view of the very favorable results already obtained I earnestly recommend that the funds required for completing the improvements in accordance with the approved plan may be promptly provided.

As soon as an appropriation for this object is made available it is proposed to expend it in repairing the damages caused by the late cyclone; in completing the long dam at Oyster Bed Shoal; raising and strengthening Cross Tides Dam where necessary; building a new wing-dam from the lower end of Jones Island, and in dredging at points where it may be required.

This work is located in the collection district of Savannah, Ga., at the port of entry. Amount of duties collected in 1885, $45,132.40.

Since the works of improvement were commenced the following appropriations have been made:

By act of Congress approved June 23, 1874	$50,000
By act of Congress approved March 3, 1875	70,000
By act of Congress approved August 14, 1876	62,000
By act of Congress approved June 18, 1878	70,000
By act of Congress approved March 2, 1879	100,000
By act of Congress approved June 14, 1880	65,000
By act of Congress approved March 3, 1881	65,000
By act of Congress passed August 2, 1882	200,000
By act of Congress approved July 5, 1884	200,000
Total	882,000

The total expenditures to June 30, 1886, were $879,056.10.

To complete the work of improving Savannah Harbor and River, Georgia, in accordance with the approved project, dated January 16, 1882, there will be required the additional sum of $330,000.

The following drawings and papers are transmitted herewith, viz:

Sheet I. Chart showing works constructed between Fig Island and Elba Island to June 30, 1886.

Sheet II. Chart showing works constructed between Elba Island and Cockspur Island to June 30, 1881.

Report of First Lieut. O. M. Carter, Corps of Engineers, with commercial statistics of the port.

Money statement.

July 1, 1885, amount available		$50,385 60
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$47,168 21	
July 1, 1886, outstanding liabilities	273 49	
		47,441 70
July 1, 1886, amount available		2,943 90
Amount appropriated by act approved August 5, 1886		150,000 00
Amount available for fiscal year ending June 30, 1887		152,943 90
Amount (estimated) required for completion of existing project		180,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		180,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

REPORT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., June 30, 1886.

COLONEL: I have the honor to submit the following report of operations for improving the harbor at Savannah, Ga., during the fiscal year ending this date.

The work of constructing wing-dams was continued under the contract in force at the beginning of the year, until September, 1885.

Dredging, which had been temporarily suspended, prior to the close of last year, was resumed in August, and was continued until October, when operations were suspended from lack of funds. During the year an accurate line of levels was run from Cross Tides to Fort Pulaski, for use in the further study and improvement of the river. All existing works were examined during the present month in order to determine their condition. The adjacent channels were also carefully sounded out during the same period.

CROSS TIDES DAM.

At the close of the last fiscal year the crest of this dam was at the level of mean high water, the work of bringing it to this height having been done as explained in my report for 1885.

Several slight breaks took place in the dam during the year caused by the unequal settlement of the log-mattress foundation. These breaks were repaired from time to time by using brush fascines and stone. Experience has shown that riprap stone of the size called for by the specifications will not hold here above mean low water, but very good results were obtained by building the stone into a sort of dry masonry wall. Even this has not held during the entire year. A great deal of stone has been thrown off the dam by fishermen and others interested in securing a short water route from the Back River to Savannah, and these small breaks have rapidly enlarged under the pressure of the head of water at the dam.

Gauge-readings taken in January and February of this year show a difference, in the mean low-water levels above and below the dam, of 2.9 feet. In time of freshets this difference is greater. There are at present two breaks near the middle of the dam, one of which is 225 feet long and from 3 feet above to 3 feet below mean low water; while the other is 70 feet long and from 1 to 5 feet above mean low water. The crest of the rest of the dam has not changed since last year's report. The deep-water pockets above and below the dam have deepened somewhat during the year but their areas have not materially enlarged.

UPPER RICE-MILL.

No work was done here during the year. Two small shoals have formed in the channel, just above the foot of West Broad street, the least mean high-water sounding, over which is 20.5 feet. There is still a practicable channel, however, which is 21 feet deep at the same stage. A shoaling of 1 foot has taken place here during the year.

GARDEN BANK SHOAL.

The wing-dams at this point are in good condition. The shoaling opposite the entrance of the discharge-pipe from the gas-works, mentioned in my last year's report, continued, and in August, 4,953.89 cubic yards were dredged from the channel in this locality. The length of the shoal is about the same as at the close of the last fiscal year, but the channel defined by the 12-foot mean low-water curves has narrowed somewhat during the year. The least mean high-water sounding in the channel is now 19.4 feet, a shoaling of six-tenths of a foot having taken place since the close of last year. There are lumps near the channel, however, on which the high-water depth is only 18 feet, and dredging will soon be imperatively necessary at this locality. Large volumes of sand are washed from the city streets into the channel here at every rain storm, and it will be difficult to keep this shoal removed as long as this is allowed to continue.

WRECKS CHANNEL.

During the months of July and August work on the Fig Island jetty was continued and its crest brought up to about 5 feet above mean low water. In the cyclone of August 25 some damage was done to that portion of the jetty between spurs 10 and 11. The rest of the jetty is in good condition, with the exception of a few gaps between spurs 1 and 4, which were caused by the tearing out by unknown parties of stone and brush to make room for the passage of small boats. The general crest of the jetty has not changed. The silting up between the spurs and along the north side of the jetty still continues, but the growth of marsh-grass does not seem to have advanced any since my last report. The least mean high-water sounding in this channel is now 21.1 feet, a deepening of 1 foot during the year. Some shoaling has taken place near buoy No. 14, at the lower end of the channel, which indicates the necessity for the further extension of the Fig Island jetty.

OBSTRUCTIONS.

Wing-dam No. 15 is in good condition. A cut 45 feet wide was made in September, to connect the 15-foot mean low-water pools above and below this shoal. The material removed was coarse sand. From causes mentioned in my last year's report some slight shoaling has taken place since this dredging was done. The last mean high-water sounding over this shoal is at present 20.9 feet, which is 1.1 foot more than at the close of the last fiscal year.

UPPER FLATS.

Wing-dams Nos. 4 and 23 have not changed since last year's report. The gaps existing in Nos. 6 and 25, at the close of last year, were filled with brush fascines and stone and both dams brought to an even crest. They are now in good condition. No. 27, which had settled slightly in one or two places, was repaired by redistributing the stone on its crest. Both it and No. 10 are in good condition and neither shows any sign of settlement. The width and depth of the channel at this crossing have been well maintained, and no shoaling has taken place except at the lower end, between dams Nos. 10 and 27, where, for a distance of 400 feet, the depth is about 8 inches less than at the close of last year. In September a cut 440 feet long, 45 feet wide, and 15 feet deep, at mean low water, was dredged through this shoal. The least mean high-water sounding in the channel here at present is 21.4 feet.

LOWER FLATS.

Wing-dams Nos. 14 and 29 were slightly injured in the cyclone of last August. About 100 feet of the outer end of No. 29 is now 2 feet below mean low water. The outer half of No. 14 varies from 3 feet above to 2.5 feet below that level. Neither dam shows any sign of settlement. Wing-dam No. 13 is still unfinished.

In August a cut 1,960 feet long and 45 feet wide was dredged to 15 feet deep at mean low water, for the purpose of connecting the deep-water pools above and below this shoal. The upper portion of the cut has deepened since that time from 1 to 3 feet, and the lower portion—opposite wing-dam No. 13—has shoaled about 6 inches. The least mean high-water sounding on the range is now 21.5 feet; a deepening of 1 foot during the year.

LONG ISLAND CROSSING.

Wing-dams Nos. 26 and 33, which at the close of the last fiscal year had settled in a few places from 4 to 6 feet, were brought to an even crest in July with brush fascines and stone. These dams were both injured by the August storm. The outer half of dam No. 33 is at present about up to the level of mean low water, while the inner half is about 5 feet above that level. The crest of dam No. 26 varies from about 1 foot above to about 4 feet below that level.

The channel defined by the 15-foot mean low-water curves is somewhat more irregular than at the close of last year, and has narrowed to 300 feet between the dams. Between stations Nos. 1 and 2 on Long Island a shoaling of about 2 feet has taken place during the year, the 15-foot mean low-water curves being now separated from each other by a shoal about 4,100 feet in length, over which there is a least mean low-water depth of 13.9 feet. The upper 3-fathom curve below Venus Point has not changed during the year, but the lower curve does not extend up-stream as far by 1,020 feet as at the close of last year.

In some places to the northward of the channel a shoaling of from 3.5 to 4 feet has taken place. The time has now arrived when the proposed contracting works at the lower end of Jones Island should be built.

OYSTER BED SHOAL.

When work was necessarily suspended in September wing-dam No. 31 was unfinished. Its crest throughout is at about mean low water. It does not show any sign of settlement. The channel over the old shoal near spar-buoy No. 11, for the improvement of which this dam was built, has deepened in places from 3 to 4 feet during the year. The width has been maintained, and this shoal can be considered permanently removed.

MISCELLANEOUS.

The Big Gap Dam was repaired in September, by filling up the hole at its eastern extremity with brush fascines and loading them with riprap-stone. The gap was so irregular in appearance that fascine mattresses could not be used; but at slack low water the hole was filled with single fascines, these being placed close together, with their axis perpendicular to the axis of the dam, and loaded heavily with stone.

With the exception of a gap about 25 feet in width near its middle this dam is in good condition.

Philbrick's Cut Dam was repaired in the same manner as the Big Gap Dam. There is at present a gap near the southern end of the dam wide enough for the passage of small boats. The rest of this dam is all right.

All of the other closing dams on the river are in good order.

At the close of active operations in October the river was in most excellent condition, but work has been at a stand-still since that time on account of lack of funds, and some shoaling has taken place, which could have been controlled for a much smaller sum than will be required for its removal.

During the past year several vessels of over 20 feet draught have passed from the city to the sea, and *vice versa*, on a single tide. In one instance a vessel drawing 20 feet 9 inches was brought in; a draught of 1 foot 9 inches greater than was ever before brought to the city wharves. The record of draughts, which I append was compiled from the pilot records by Captain Kennedy, the harbor-master of the port, and shows that from 1872 to the present time the available depth of water from the city to the sea has increased over 3.5 feet. At many points this increase has been much greater, and much larger vessels are now able to navigate the river than in former years.

Savannah is the chief port of the South Atlantic coast, the second cotton port of America, and the first naval-stores port of the world. Her commerce for 1885 was over $67,000,000. I append a table of commercial statistics of the port, furnished by the collector of customs.

Charts of the river from Fig Island to Elba Island and from Elba Island to Cockspur Island are transmitted herewith.

The following table shows the work done during the year:

JETTY WORK.

Date, 1885.	Locality.	Mattresses.	Fascines.	Stone.
		Sq. yds.	*Cu. yds.*	*Cu. yds.*
July, August, September	Dam No. 31	12,042.82	....	2,106.76
July, August	Fig Island Jetty	....	1,540.07	198.46
July, August, September	Cross Tides Dam	....	162.82	1,750.23
July	Philbrick's Cut Dam	....	154.25	121.85
July, August, September	Dam No. 6	....	829.03	66.15
July, September	Dam No. 25	....	712.99	98.54
July	Dam No. 26	....	166.42	....
July	Dam No. 33	....	140.00	....
September	Big Gap Dam	....	838.62	182.66
Total		12,042.82	4,043.70	4,526.35
By previous reports (1884-'85)		105,095.86	5,634.49	21,202.94
Aggregate during contract		117,138.68	9,678.19	25,729.29

DREDGING.

Date, 1885.	Locality.	Cubic yards.
August	Garden Bank	4, 953. 89
August, September	Lower Flats	8, 167. 41
September	Upper Flats	1, 687. 78
September	Obstructions	3, 134. 05
September, October	Wrecks	20, 531. 43
Total		38, 474. 51
By previous reports, (1884–'85)		98, 114. 20
Aggregate during contract		136, 588. 71

Mr. A. S. Cooper, assistant engineer, has rendered valuable services during the entire year.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieutenant, Corps of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels and commerce at Savannah, Ga., from January 1, 1873 *to December* 31, 1885.

ARRIVED.

Years.	Coastwise.			Foreign ports.						Total.			Greatest draught.*
				American vessels.			Foreign vessels.						
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	
													Feet.
1873	463	381, 595	11, 934	34	16, 140	383	213	119, 316	2, 999	710	517, 051	15, 316	17. 50
1874	418	354, 700	10, 048	66	41, 030	847	284	182, 517	4, 232	768	578, 247	15, 127	17. 50
1875	370	310, 877	10, 102	67	39, 298	781	222	145, 748	3. 290	659	495, 923	14, 173	17. 50
1876	355	320, 015	10, 348	58	40, 832	987	260	169, 649	3, 865	673	530, 496	15, 200	17. 75
1877	333	379, 826	10, 867	54	40, 948	951	287	168, 247	3, 950	674	589, 021	15, 768	18. 25
1878	322	385, 532	10, 688	61	45, 208	1, 576	326	235, 787	5, 814	709	666, 527	18, 078	18. 50
1879	319	411, 794	8, 235	30	21, 994	439	279	198, 040	3, 960	628	631, 828	12, 634	17. 75
1880	338	446, 881	9, 996	14	7, 724	170	244	172, 224	3, 533	596	626, 829	13, 699	18. 33
1881	383	508, 422	11, 069	21	10, 729	237	254	151, 463	3, 474	658	670, 614	14, 780	19. 00
1882	391	544, 448	12, 605	11	4, 865	106	204	115, 061	2, 718	606	664, 374	16, 429	19. 00
1883	380	408, 226	10, 659	10	4, 115	90	160	87, 025	1, 965	550	559, 366	12, 714	18. 25
1884	388	482, 917	13, 735	14	5, 632	116	287	174, 676	3, 984	689	663, 225	17, 835	19. 00
1885	395	493, 610	14, 622	12	5, 058	125	251	163, 321	3, 416	658	661, 989	18, 163	20. 75

CLEARED.

1873	466	398, 050	13, 740	65	30, 102	689	224	129, 164	3, 194	755	557, 316	17, 632	17. 50
1874	480	407, 295	12, 748	71	40, 397	822	229	145, 038	3, 437	780	592, 730	17, 007	17. 50
1875	319	284, 831	9, 376	72	39, 311	804	195	128, 086	2, 924	586	452, 228	13, 104	17. 50
1876	410	361, 999	11, 222	80	49, 483	1, 163	185	119, 699	2, 827	675	531, 181	15, 212	17. 75
1877	400	439, 370	12, 081	65	44, 829	1, 066	161	103, 342	2, 589	626	587, 541	15, 736	18. 25
1878	378	418, 958	10, 475	64	40, 128	1, 255	260	183, 757	5, 375	702	642, 843	17, 105	18. 50
1879	365	442, 734	8, 834	36	24, 891	497	223	156, 470	3, 129	624	624, 095	12, 460	17. 75
1880	310	434, 864	10, 108	26	12, 536	271	242	168, 255	3, 446	578	615, 655	13, 825	18. 33
1881	369	508, 422	11, 458	22	13, 052	253	261	180, 579	3, 745	652	702, 053	15, 456	19. 00
1882	350	506, 213	11, 917	23	9, 155	205	209	135, 375	3, 023	582	650, 743	15, 145	19. 00
1883	355	415, 720	9, 780	10	4, 115	90	165	87, 400	2, 015	530	507, 235	11, 885	18. 25
1884	360	452, 802	13, 363	15	5, 634	131	288	194, 075	4, 315	663	652, 511	17, 809	19. 00
1885	414	502, 773	14, 672	20	8, 722	148	228	154, 858	3, 344	662	666, 353	18, 164	20. 17

* Compiled by the harbor-master.

COMMERCE.

Years.	Value of exports.	Value of imports.	Duties collected.	Years.	Value of exports.	Value of imports.	Duties collected.
1873......	$29,850,275 00	$890,664 00	$160,011 77	1880.....	$49,297,981 25	$660,974 00	$78,458 41
1874......	50,500,945 94	788,220 00	110,492 74	1881....	47,448,117 00	932,512 00	856,550 22
1875......	46,004,295 60	511,818 00	61,625 44	1882.....	48,349,033 00	657,255 00	61,148 70
1876......	41,236,581 00	511,528 00	58,103 86	1883.....	50,890,937 00	567,182 00	65,245 34
1877......	33,569,981 00	564,937 00	34,959 93	1884.....	50,934,184 00	696,434 00	49,147 28
1878......	41,793,477 71	505,596 00	23,364 85	1885.....	42,253,897 00	513,286 00	45,162 49
1879......	44,980,070 89	878,782 00	27,778 73				

T. F. JOHNSON,
Collector.

First Lieut. O. M. CARTER,
Corps of Engineers.

M 7.

IMPROVEMENT OF SAVANNAH RIVER BETWEEN THE CITIES OF AUGUSTA AND SAVANNAH, GEORGIA.

Operations for improving Savannah River between the cities of Augusta and Savannah, Georgia, have been carried on, with repeated intermissions, from February, 1882, to June 30, 1885, with funds supplied by three appropriations made by Congress, aggregating $55,000.

An examination of this portion of Savannah River was made under my direction in September and October, 1880, and my report thereon, dated December 22, 1880, with plan of improvement, appears in Appendix J 6, Annual Report of the Chief of Engineers for 1881, and is printed in House Ex. Doc. No. 23, Forty-sixth Congress, third session.

The distance between the cities of Augusta and Savannah is estimated at 108 miles in a straight line, and at 248 miles by river.

For the greater part of the year the river was found to be navigable for steamboats drawing from 4 to 5 feet, but during the dry season in autumn the river is very low at various places, and boats had then to discharge and receive their cargoes at some point below Augusta.

The chief obstructions to navigation were found to comprise shoals or bars of sand, snags, floating and overhanging trees, and pile obstructions.

PROJECT OF IMPROVEMENT.

The project for improving the river recommended in my report of December 22, 1880, comprises the following works:

(1) Narrowing the river by low wing-dams where excessive widths produce or maintain bars.

(2) Aiding the accumulation of silt between the wing-dams by light hurdle traverses.

(3) Protecting the banks where needed by thin, flexible, brush mattresses weighted with stone, or in some other suitable manner.

(4) Cutting off projecting points of land.

(5) Removing existing pile obstructions.

(6) Removing snags, floating timber, and overhanging trees.

(7) Aiding the formation of the low-water channel in a few localities by dredging.

The object of the plan of improvement is to procure a low-river channel of not less than 5 feet, and the cost of the works is estimated at $91,000.

No operations were carried on during the past fiscal year from want of funds.

The following is a brief description of the work done thus far:

Nearly the whole of the first appropriation, amounting to $15,000, was expended in providing a snag-boat, designed to be used in removing obstructions, such as snags, piles, drift-logs, overhanging trees, &c. At four points of the river where the navigable channel was of deficient depth during the low-river stage, caused by undue widening of the water-way, improvement was effected by the construction of wing-dams, composed substantially as described in my last annual report. Such improvements were made at the following places, viz:

At Gardner's Bar, opposite the lower part of the city of Augusta, five wing-dams were built, extending a length of about 2,000 feet along the left, or South Carolina, bank. They reduce the width of the river, originally averaging 650 feet, to 350 feet. The right, or Georgia, shore, just below Gardner's Bar, is high and abrupt, and had been caving for many years. At eight points of this bank revetting works, similar to the dams, were constructed. They aggregate 1,375 feet in length, and protect 3,200 feet of shore-line.

At Course's Bar, 1 mile below Gardner's Bar, four wing-dams, with their land-ends resting upon the left bank, were built, and one dam from the right bank. These dams reduce the width of the river in the same manner as the works at Gardner's Bar.

The shallow crossing at Sand Bar-Ferry Bar, 4 miles below Augusta, was improved by building four wing-dams on the South Carolina side of the river, and one dam on the Georgia side, with the necessary shore protections.

A set of wing-dams was built at Blue-House Bar, 6 miles below Augusta. Two of the dams were arranged as a pair opposite to each other, a third dam was built above, and a fourth below, starting from the right and left bank of the river, respectively. They reduce the width of the river from 700 feet to 400 feet.

The operations of the snag-boat Toccoa extended from Cooney Cut Bar, 8 miles below Augusta, to Saxon's Landing, 134 miles lower down. They comprised the removal of 540 snags, 54 piles, 11 large cypress stumps, 536 leaning trees, and the wrecks of several flat-boats.

The total expenditures for the work thus far done have amounted to $57,264.85.

I am not able to make a statement concerning the present condition of the works. During the latter part of the fiscal year, when it was proposed to make an examination for the purpose, the continued high stage of the river has prevented it. It is presumed that the reaches of the river where improvements have been effected are in good order, as I have heard of no complaints made of them during the year. A thorough examination will be had as soon as practicable.

With any funds that may be made available, it is recommended to build wing-dams similar to those already constructed at points lower down the river where required, and to continue the work of removing snags, floating trees, and other obstructions from the channel-way. The Savannah River from Augusta to Savannah forms a convenient and economical transportation route for agricultural products and merchandise, and by securing a better low-river depth in the channel of navigation large tracts of country on both sides of the river and above Augusta will be materially benefited. I am informed that two steamboats have been plying regularly upon the river during the year, and that about 15,000 bales of cotton were brought from Augusta to Savannah by river this year, which in previous years were shipped by rail.

It is desirable that a sufficient appropriation should be made by Congress to complete the existing project.

This improvement is located in the collection district of Savannah, Ga. Savannah is the nearest port of entry. Amount of duties collected in 1885, $45,132.40.

Since the plan of improvement was adopted, the following appropriations have been made:

By act of Congress approved March 3, 1881	$15,000
By act of Congress passed August 2, 1882	25,000
By act of Congress approved July 5, 1884	15,000
	55,000
Received from other appropriations for use of snag-boat	2,500
Total	57,500

Of this amount the sum of $57,264.85 had been expended to June 30, 1886.

The total cost of the existing project was estimated at $91,000. As I stated in my last annual report, I am not prepared to say that this amount will carry the work to completion; the improvement, however, will extend over all the reaches of bad navigation, so as to utilize all the work done as far as possible.

Money statement.

July 1, 1885, amount available	$514 17
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	279 02
July 1, 1886, amount available	235 15
Amount appropriated by act approved August 5, 1886	15,000 00
Amount available for fiscal year ending June 30, 1887	15,235 15
Amount (estimated) required for completion of existing project	21,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	21,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

M 8.

IMPROVEMENT OF SAVANNAH RIVER ABOVE AUGUSTA, GEORGIA.

Three appropriations, aggregating $39,000, have been made by Congress since 1880 for improving Savannah River between the city of Augusta, Ga., and Trotter's Shoal, 64 miles above. The river was examined under my direction from Augusta up to the head of pole-boat navigation, near Tallulah Falls, a length of 154 miles, in November and December, 1878. My report thereon, dated February 8, 1879, is printed in Appendix I 2, Annual Report of the Chief of Engineers for 1879. I stated in the report that until a thorough examination could be made above Trotter's Shoal, any money that might be appropriated should be expended upon that portion of the river below said shoal.

Two estimates were submitted, viz:

(1) Cost of improving the river for pole-boat channel, 3 feet by 30 feet, from Augusta to Trotter's Shoal, 64 miles	$45,000
(2) Cost of steamboat channel, 3 feet by 90 feet, same route	125,000

Operations have been carried on in conformity to the first-named project.

The obstructions to be removed under the adopted project are numerous, and consist chiefly of rocky ledges running across the channels, isolated bowlders of various sizes, and shoals of gravel.

No operations have been carried on since August, 1883.

Previous to that time, the river was more or less improved at many places within the section embraced in the project, especially in the lower reach.

From the canal lock, 7 miles above Augusta, to Barksdale, 50 miles from the city, a channel was secured through the obstructions 20 feet wide and 2½ feet deep at summer low water. The work consisted in removing solid ledge rocks, bowlders and gravel, and in building wing-dams for contracting the water-way, the dams being constructed either entirely of broken stone or of brush mattresses and stone combined; 4,094 cubic yards of ledge rock, 37 cubic yards of bowlders, and 62 cubic yards of gravel were removed.

For building the dams nearly 6,670 square yards of brush-mattresses and 4,183 cubic yards of broken stone were used.

As to the amount of commerce and navigation to be benefited by completing this improvement, I beg leave to refer to my report of February 8, 1879. No additional data have been received since that time.

An examination recently made has shown that where the channel was deepened and widened by blasting of rock the river has been much improved. Some of the dams put in for the removal of sand-bars have proved effective, but in many cases they appear to have failed, as the works were not sufficiently extensive to produce the desired results.

This work is located in the collection district of Savannah, Ga., which is the nearest port of entry. Amount of duties collected in 1885, $45,132.40.

Since the work of improvement was commenced, the following appropriations have been made:

By act of Congress approved June 14, 1880	$16,000
By act of Congress approved March 3, 1881	8,000
By act of Congress passed August 2, 1882	15,000
Total	39,000

Of this amount there has been expended from the beginning of operations to June 30, 1886, the sum of $38,177.29.

Money statement.

July 1, 1885, amount available	$877 06
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	54 35
July 1, 1886, amount available	822 71
Amount available for fiscal year ending June 30, 1887	822 71
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	6,000 00

M 9.

IMPROVEMENT OF SAINT AUGUSTINE CREEK (THUNDERBOLT RIVER), GEORGIA.

Of the sum of $5,000 appropriated by act of Congress approved March 3, 1879, $1,582.34 were expended during the fiscal year ending June 30, 1881, in the partial removal of the wreck of a large timber dry-dock, which was sunk in the middle of the stream during the late civil war.

There appears to be no necessity for any further improvement of the river at this point, and no appropriation is asked.

This work is located in the collection district of Savannah, Ga. Savannah is the nearest port of entry. Amount of import duties collected in 1885, $45,132.40.

Money statement.

July 1, 1885, amount available	$3,417 66
July 1, 1886, amount available	3,417 66

M 10.

IMPROVEMENT OF ROMERLY MARSH, GEORGIA.

The water route through Romerly Marsh forms a part of the inland passage from the Savannah River, Georgia, to the Saint John's River, Florida. Romerly Marsh is situated to the southeast of Skiddaway Island, between Wassaw Sound on the north and Ossabaw Sound on the south.

My report, dated November 15, 1880, of an examination of Romerly Marsh, made under my direction in the latter part of the year 1880, contains descriptions of four different routes that might be selected for improvement, with estimate of cost of each. The report is printed as Appendix J 19 of the Annual Report of the Chief of Engineers for 1881, and in House Ex. Doc. No. 19, Forty-sixth Congress, third session.

Two appropriations aggregating $20,000 have thus far been made by Congress for improving Romerly Marsh, Georgia, "by the route designated in the survey of the engineers as route numbered four." The sum of $5,000 was contributed in 1883 for facilitating the work by the Georgia and Florida Steamboat Company, under conditions stated in my annual report of that year and approved by the Department, and, in September, 1885, when the second appropriation made by Government was exhausted, additional funds were again supplied by private parties to continue and complete the work under similar conditions.

PROJECT OF IMPROVEMENT.

Route numbered four, named in the act of Congress, is the most easterly one of those that were examined. By this route the northerly creek, known as "Dead Man's Hammock Creek," which flows through the marsh and empties into Wassaw Sound near the mouth of Romerly Marsh Creek, is to be connected by a cut with Wassaw Creek, which flows into Odingsell River not far from the point where the latter empties into Ossabaw Sound. The mean rise and fall of the tide is here about 7 feet.

By this route the existing passage through Romerly Marsh, which is exceedingly crooked, with sharp bends and insufficient low-water depths, will be avoided, and replaced by one which can be navigated with much greater convenience, although it will be over 2 miles longer.

It is proposed that the new route shall have not less than 7 feet depth at mean low tide, with a minimum bottom width of 48 feet, and side slopes of one height to three base, or steeper, if practicable. The length of the cut through the marsh will be 1,156 yards.

The cost of the project was estimated at $38,720, but has been exceeded because of the intermittent method of carrying on operations, unavoidable from periodical lack of funds, which necessitated doing over again a considerable portion of the work to restore the cut to its proper depth and width which had been diminished by inflowing mud and washing down of banks during periods of forced suspension of operations.

OPERATIONS PRIOR TO JULY 1, 1885.

The work of opening the cut by route No. 4 has been done exclusively by dredging, which was commenced in May, 1883. It was started at the northern end of the line, at a bend of Dead Man's Hammock Creek, about 1¾ miles by water from the confluence of the creek with Romerly Marsh Creek, at the head of Wassaw Sound.

On June 30, 1885, the cut had been opened for a length of 1,720 feet, with bottom widths of from 40 to 50 feet and a depth of 7 feet at mean low water. The width at the level of the marsh varied from 105 to 135 feet, according to the elevation of the ground above low water. One hundred and one thousand one hundred cubic yards of material were removed, of which about 20 per cent. was taken out in restoring depths and widths previously obtained, but lost during the time when operations were suspended.

The total expenditures to June 30, 1885, including the sum of $5,000 contributed by the steamboat company, were $21,156.63.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

On July 1, 1885, a balance of $3,834.37 from the last appropriation was available for continuing the work. It was expended during the months of July and August, 1885, under the contract mentioned in my last annual report. Operations under this contract terminated on September 1, 1885. From the beginning of the fiscal year to the date just named, 11,343 cubic yards of mud and sand had been removed and the cut extended 300 linear feet toward Wassaw Creek.

A proposition was made about this time by private parties to finish the work at their own expense and risk, in accordance with the approved project and under the supervision of the engineer officer in charge. It being desirable to complete the cut and open it to navigation as soon as possible, I recommended that the proposition be accepted, upon condition that the money furnished by the parties in interest should be placed in the hands of the engineer officer in charge, and the work prosecuted under his official supervision and inspection, and that the United States should not be liable for its reimbursement. The recommendation was approved by the Secretary of War, under date of September 25, 1885, and operations were at once resumed.

In April, 1886, the solid cut through the marsh was completed, and a channel of 50 feet width at the bottom and 7 feet depth at mean low water opened through the shallow water beyond the mouth of the marsh-cut until sufficiently deep water in Wassaw Creek was reached.

Under this arrangement there were removed, from September, 1885, to April, 1886, 99,120 cubic yards of mud and sand, including 23,882 cubic yards taken from Wassaw Creek and about 5,000 cubic yards from older portions of the solid cut, where some shoaling had occurred before it had been fully opened, due to the absence of through currents.

The total length of continuous cut is 4,117 feet, 3,547 feet of which are through the solid marsh and 570 feet at the head of Wassaw Creek. In the latter creek, a short distance lower down, additional cuts were made, of an aggregate length of 1,600 feet, through three shoals, marked Nos. 1, 2, and 3 on the accompanying chart.

The establishment of Romerly Marsh Cut, known as "Route numbered four," has required the removal of 211,563 cubic yards of material.

REMARKS ON THE WORK.

A recent examination has shown that, for all practical purposes, the improvement contemplated by the project has been accomplished. A navigable channel now exists through the marsh, having a bottom width of about 50 feet, and generally a depth of 7 feet at mean low water. Since the opening of the cut it has commenced to deepen throughout by scour, except at its southern end, where the tides from Wassaw Sound and Ossabaw Sound meet. In short, while there are still some places where dredging would be desirable, there are none where it is necessary for the convenience of navigation.

The new route is undoubtedly an improvement upon one formerly used, which was objectionable on account of its deficient depths and excessive tortuousness. The work is also believed to be practically permanent, inasmuch as the tidal currents have now an unobstructed flow, and will therefore prevent the settling of deposits of material. It is possible, as suggested in my report of November 15, 1880, that some dredging may be required occasionally at the points where the tides meet.

The final cost of this improvement has exceeded the original estimate of $36,720, for reasons repeatedly given in my former reports—th unavoidable deterioration of the incomplete cut during the time whe operations were suspended from lack of funds. The opening of a channel from the southern end of the Marsh Cut into Wassaw Creek also required the removal of a larger quantity of material than was anticipated Considering the intermittent method of supplying funds for carrying o the work, it is thought that it has been done at a reasonable pric There can be no doubt that the total expenditure would have been considerably increased if Government had not accepted the offer made b private parties to supply funds with which to carry the work to completion. For this reason, and because the benefit of the improvemen could thus be secured to commerce at a much earlier date, I recommende to the Department in my letter of April 13, 1886, that the amount aske for in my last annual report, $14,000, be increased to $23,300, to b supplied in one appropriation, to cover the expenses for the work don since September 2, 1885.

I have not been able to obtain statistics showing the amount and valu of commerce interested in this improvement.

The improved route through Romerly Marsh is located in the collection district Savannah, Ga. Savannah is the nearest port of entry. Amount of duties collect in 1885, $45,132.40.

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Since this improvement commenced, the following appropriations have been made:

By act of Congress passed August 2, 1882	$10,000
By act of Congress approved July 5, 1884	10,000
Total	20,000

The total expenditures from the beginning of operations to June 30, 1886, including the amounts supplied on two occasions by private parties, were $46,712.57.

A chart showing improvement of Romerly Marsh to June 30, 1886, is herewith transmitted.

Money statement.

July 1, 1885, amount available		$3,843 37
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$3,346 70	
July 1, 1886, outstanding liabilities	100 47	
		3,447 17
July 1, 1886, amount available		396 20
Amount appropriated by act approved August 5, 1886		17,475 00
Amount available for fiscal year ending June 30, 1887		17,871 20
Amount (estimated) required to pay for completing existing project Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		4,633 78

M 11.

IMPROVEMENT OF ALTAMAHA RIVER, GEORGIA.

The Altamaha is the most important river in Georgia, lying entirely within the boundaries of that State. It is formed by the confluence of the Oconee and Ocmulgee. Its length is 155 miles, with a southeasterly course, and it empties into the Atlantic Ocean through Altamaha Sound, below the town of Darien.

The river was examined under my direction in the latter part of the year 1880. My report, dated November 27, 1880, with project of improvement, is printed in Appendix J 9, Annual Report of the Chief of Engineers for 1881, and in House Ex. Doc. No. 19, Forty-sixth Congress, third session.

The chief obstructions to the navigation of the Altamaha consist in rock ledges running nearly across the river, sand-bars, and snags.

PROJECT OF IMPROVEMENT.

The project contemplates the establishment of a steamboat channel of 80 feet width and 3 feet depth at low-river stage, the cost of which was very roughly estimated at $60,000. This will probably need to be increased, as stated in previous reports. The estimate provides for the removal of about 10,500 cubic yards of rock, of an old wreck and pile obstructions, and of several thousand snags, all in the fresh-water reaches of the river; and also for the dredging of about 8,000 cubic yards of material in the vicinity of Darien. The cost of improving localities where sand-bars occur is included in the estimate, but the latter is but roughly approximate in that respect. I said in my first report that these places should be instrumentally surveyed before a proper plan for improving them can be devised.

Three appropriations, aggregating $35,000, have thus far been made for improving Altamaha River.

OPERATIONS PRIOR TO JUNE 30, 1885.

The first appropriation for this improvement was expended in providing a snag-boat suitable for service on the river. It was completed in February, 1882, and has rendered efficient service in the removal of obstructions from the numerous reaches between the town of Darien and Ohoopee White Bluff, a distance of 115 miles by river. During a period of about eight months, in which snagging operations could be carried on, 355 snags, 2 piles, and 618 overhanging trees were removed.

The following work was performed under contracts referred to in my former annual reports:

A channel was opened through the rock ledges at Town Bluff and at Piney Bluff, 1⅝ miles and 19½ miles, respectively, from the junction of the Oconee and Ocmulgee. At both of these localities a passage was cut through the rock, fully 100 feet wide and 4 feet deep at low-river stage, securing a serviceable and permanent channel for rafts and light-draught steamboats from Lumbertown, on the Oconee, to some distance below Piney Bluff, over 50 miles by river. This work involved the removal of 1,799 cubic yards of solid rock.

Subsequently work was undertaken for the improvement of Beard's Bluff Bar, situated 63 miles by river below the junction, or the head of Altamaha River. The bar consists of coarse shifting sand, and is due to the abrupt widening of the river and slackening of currents at the entrance of Beard's Bluff Lake, a sheet of water about 1 mile in length. To secure the removal of the bar by scour a training-wall was built extending 1,744 feet down-stream from the sand-spit between river and lake, with two short spur-jetties on the channel side of the upper portion of the training-wall. These dams were formed of courses of brush fascines, either laid one at a time or made into mattresses, the fascines being 15 feet long and from 12 to 15 inches thick at the butt end. Each course of fascines was covered with an average thickness of 8 inches of broken stone and 4 inches of coarse gravel. Below the down-stream end of the training-wall, the opposite bank, being exposed to erosion, was protected by a revetment of fascines staked to the bank. The last-named work was not quite finished at the close of the preceding fiscal year.

In constructing the works at Beard's Bluff, 3,051 cubic yards of fascines, 650 cubic yards of riprap-stone, and 299 cubic yards of gravel were employed. The total expenses from the beginning of operations to June 30, 1885, were $32,085.34.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

But little was accomplished toward further improvement of Altamaha River during the past fiscal year.

The balance on hand on July 1, 1885, amounted to $2,914.66. A part of this sum was expended during that month in completing the work at Beard's Bluff Bar, by adding four spur-jetties on the channel side of the lower portion of the training-wall, completing the upper part of the revetment of the left bank, and building three reveting spurs a little below the lower end of the bank revetment just referred to.

These operations were performed under the contract made on December 5, 1884, with Mr. E. H. Gaynor, details of which were communicated in my last annual report. From July 1 to July 15, 1885, the contractor furnished and put into the work 494.53 cubic yards of brush fascines, 161.27 cubic yards of stone, and 129.59 cubic yards of gravel.

The balance of funds then remaining available being too small to warrant beginning operations elsewhere, the contract was terminated July 15, 1885.

CONDITION OF THE RIVER AND EFFECTS OF THE WORKS.

An examination of the works at Beard's Bluff Bar was made in the last month of the fiscal year, but the river being at a high stage a close inspection was impossible. From soundings taken, the training-wall seemed to be in good order except that in the central portion the crest appeared to have lowered somewhat, from what cause could not then be ascertained. The shore protection was damaged in some parts. The works had done good service, however; the channel had more than the required depth of water.

While the upper reach, from the head of the Altamaha to Piney Bluff, is generally in good condition, complaints have recently been made that some bowlders interfere with navigation at Town Bluff and Piney Bluff, the same places where passages were cut through the rock-ledges some years ago. This matter will be investigated when a new appropriation has been made, and when the river is at a sufficiently low stage.

At Golden Grove Bar, near Piney Bluff, and at "Hell's Shoals," about 17 miles lower down, rocky reefs and bowlders are reported as requiring early attention.

The lower reaches of the river, from Darien to Steamboat Cut, 55 miles, have been well cleared of obstructions by the snag-boat Toccoa. Higher up, to Ohoopee White Bluff, 115 miles from Darien, a good deal of snagging work has been done, but more is yet required. It is also necessary to make a cut at Bug's Suck, and enlarge the cut-off made by the river at Doctor Creek; and it is thought that wing-dams must be constructed for the removal of shoals at Sansavilla Landing, at Ohoopee White Bluff, Ohoopee Cut, and Marrowbone Bar; Cooper's Bar, 6 miles above Darien, especially needs improvement; there is scarcely any water over it at low tide.

With any funds that may become available, improvements will be made at the points named above, in the order of their importance.

In former annual reports I took occasion to point out the importance of Altamaha River as an economical and convenient route for bringing the products of the forests and rice-fields of the State of Georgia to market. The area drained by the Altahama and its tributaries is estimated at 14,000 square miles, and Darien is the natural shipping port for its produce.

To the accompanying report of my assistant, First Lieut. O. M. Carter, Corps of Engineers, is appended an interesting communication, with commercial statistics, from Mr. W. R. Grubb, deputy collector of the port of Darien, to which attention is invited. It appears that during the eleven years from January 1, 1875, to January 1, 1886, the shipments of timber and lumber (pitch pine), both foreign and coastwise, amounted to 762,046,041 feet, valued at $11,043,013,90. The rice shipments during the same period were valued at $924,000. The value of exports of naval stores during the six years from 1880 to 1885 is estimated at $305,000, and it is reported that the annual shipments are increasing. Mr. Grubb thinks that the port of Darien does not now enjoy the full benefit of the trade in timber which it legitimately should have, owing to the shoaling of Doboy Bar. In fact it appears from his tables that the greatest draught of vessels has gradually but steadily diminished from 22 feet in 1875 to 18½ feet in 1885. A considerable portion of the timber is for that reason not taken over the bar, but brought from Darien to Sapelo and Saint Simon's, and the value of such cargoes is recorded at the custom-houses of Brunswick and Savannah.

It is recommended that early provision be made by Congress for the completion of the improvement of Altamaha River, and for beginning that of Darien Harbor and Bar.

This work is located in the collection district of Brunswick, Ga. Darien is the nearest port of entry. Amount of duties collected in 1885, $2,359.01.

Since the existing project for improving Altamaha River was adopted the following appropriations have been made for the work:

By act of Congress approved March 3, 1881	$5,000
By act of Congress passed August 2, 1882	15,000
By act of Congress approved July 5, 1884	15,000
Total	35,000

Of this amount there had been expended to the close of the fiscal year ending June 30, 1886, the sum of $34,458.13.

An additional sum of $40,000 is required to be appropriated to complete the project, which makes the total cost $75,000, or $15,000 more than originally estimated. This increase is necessary to provide for the expense of building wing-dams and training-walls, to remove bars, and construct bank revetments at some points not covered by the first estimate.

A sketch, showing improvements at Beard's Bluff Bar in 1886, and the report of First Lieut. O. M. Carter, Corps of Engineers, with commercial statistics of the port of Darien, are transmitted herewith.

Money statement.

July 1, 1885, amount available		$2,914 66
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1. 1885	$2,332 79	
July 1, 1886, outstanding liabilities	40 00	
		2,372 79
July 1, 1886, amount available		541 87
Amount appropriated by act approved August 5, 1886		20,000 00
Amount available for fiscal year ending June 30, 1887		20,541 87
Amount (estimated) required for completion of existing project		30,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

REPORT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., June 30, 1886.

COLONEL: I have the honor to submit the following report of operations for improving Altamaha River, Georgia, during the fiscal year ending this date.

Operations were continued at Beard's Bluff, under the contract in force at the be-

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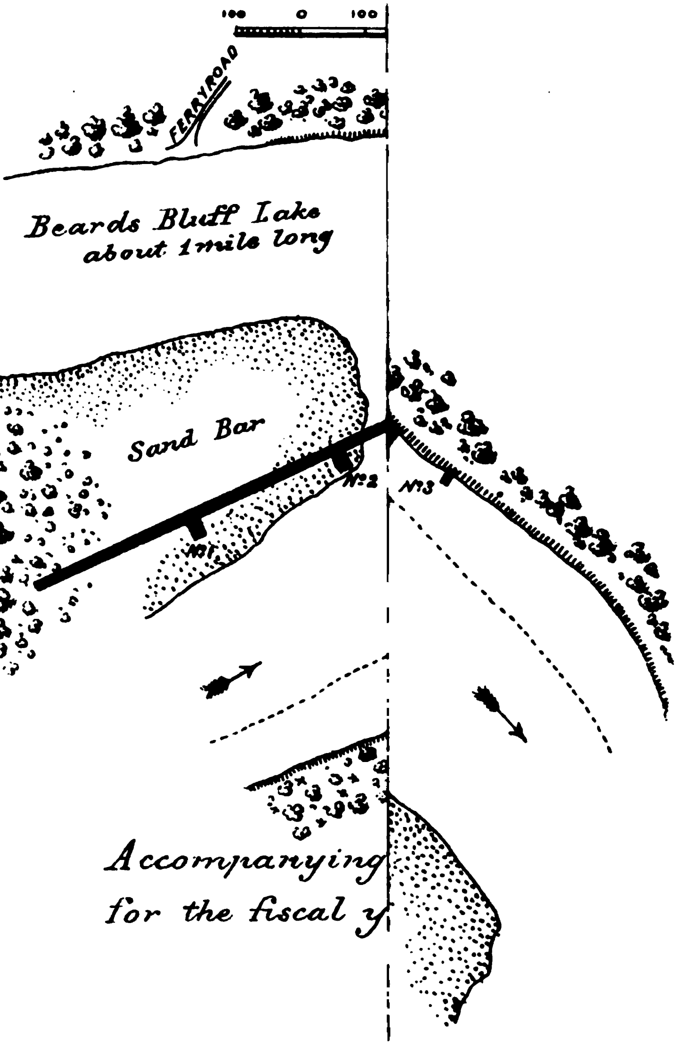

Accompanying
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ginning of the year, until July 15, 1885, when the project was completed. The character of the work is explained in my last year's report. The sketch herewith shows the improvement in its completed state, and the following table exhibits the work done:

Character of work.	Stone.	Fascines.	Gravel.
	Cubic yds.	*Cubic yds.*	*Cubic yds.*
Training-wall	75.29	117.80	54.59
Shore protection	85.98	376.73	75.00
Total	161.27	494.53	129.59
By previous reports (1884-'85)	649.93	3,050.85	298.85
Aggregate	811.20	3,545.38	428.44

Nothing was done by the snag-boat during the year. An examination of the work at Beard's Bluff was made in June. The river was so high that none of the mattresses were visible; but careful soundings were taken over the work and in the channel.

The training-wall appears to be in good condition, and shows no sign of settlement except near the middle, where it is probable that some of the work has been torn away by persons connected with the ferry.

A portion of the shore protection has been washed away and some slight caving has taken place here. Some caving has also taken place in the bight above the work and at a point on the right bank of the river about opposite the middle of the training-wall.

The increase of water has been marked since the completion of the work, there being now nowhere less than 9 feet of water in the channel, with the Doctortown gauge-reading 8.5 feet.

Golden Grove Bar, at the lower end of Piney Bluff reach, is now the worst shoal on the river, and work at this place and at Hells Shoals is much needed.

Steamboat-men also complain of bowlders in the channel at Town Bluff and Piney Bluff. The lower portion of the river, from Doctortown to Darien, is in about the same condition as at the close of last year.

Mr. R. L. Hicks, owner and master of the only steamboat plying on the river, estimates the value of freight handled by his boat during the year at $302,000, an increase of $100,000 over last year.

Mr. R. W. Grubb, deputy collector of the port of Darien, has furnished valuable and interesting information respecting the commerce of the river. His reports appended hereto.

The examination of the river was made by Mr. J. H. Westerfield, assistant engineer, who has for several years had charge of the snag-boat on this river and on the Savannah, and who has done much excellent work on both rivers.

Very respectfully your obedient servant,

O. M. CARTER,
First Lieut., Corps of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF THE PORT OF DARIEN, GEORGIA.

Articles, &c.	Average annual value.	Total value from January 1, 1875, to January 1, 1886.
Exports of timber and lumber (pitch pine):		
Foreign shipments, as per tabulated report, 583,816,741 superficial feet.	....	$7,090,283 00
Coastwise shipments, as per tabulated report, 178,729,300 superficial feet	....	2,949,730 90
Rice:		
Coastwise shipments	$84,000 00	924,000 00
The figures given above are the result of careful investigation, and due consideration has been given to the partial failure of the crops of certain years, and to the fluctuation of prices.		

COMMERCIAL STATISTICS OF THE PORT OF DARIEN, GEORGIA—continued.

Articles, &c.	Average annual value.	Total value from January 1, 1875, to January 1, 1886.
Naval stores:		
Coastwise shipments from 1880 up to and including 1885		$305,000 00
In the year 1880 the value of naval stores shipments amounted to $12,000. The operations have gradually been extended, until in 1885 the value of shipments, from reliable figures, amounted to $66,000. In 1886 it is estimated they will reach $85,000. Shipments are made in small sailing vessels and in steamers.		
Cypress:		
Prior to 1886 but little attention was given to this wood. Some enterprising Northern gentlemen, the Messrs. Van Gilder & Sons, discovering its abundance along the Altamaha, have now erected a mill at Darien expressly for the manufacture of cypress. This has given a decided stimulus to the industry, and it bids fair to become flourishing ere long. Small parcels of this wood have been shipped for many years. The first complete cargo was shipped during 1886, and before the present year ends two more cargoes will be shipped.		
Hard woods:		
Coastwise and foreign shipments		25,000 00
Considering the great quantities of the various kinds of hard woods that may be found along the Altamaha the trade in these woods has not been developed to the extent it deserves. Few entire cargoes have been shipped, but small parcels of oak, ash, hickory, &c., are frequently sent along with pine cargoes. The great obstacle in the way of extensive shipments of oak is the costly and annoying transportation to Darien, it being necessary to attach it to pine or lighter woods to prevent it from sinking. Those of our business men who have any experience in this line are of the opinion that in order to engage in the shipment of oak a liberal investment of capital for flats, tow-boats, &c., would be necessary, but the unsatisfactory state of affairs produced by the insufficiency of water on the bar does not tend to encourage any such investment.		
Hides	$1,000 00	11,000 00
About five hundred hides have been exported annually coastwise.		
Brick factory:		
Messrs. Todd & Huntington, out of a clay brought from Sansavilla, about 25 miles from Darien, manufacture an excellent brick. The clay is brought from Sansavilla in flats and the brick manufactured here. So far the manufacture has been regulated by the local demand, but the gentlemen who have the enterprise in hand are now prepared to extend their operations. The quality of the clay has been pronounced superior by experts and the supply is practically inexhaustible. Little or nothing was done in this line prior to 1886.		
Coastwise imports, not entered in custom-house		3,965,000 00
Number of steamers (coastwise) touching at Darien, &c.:		
During the years 1875, 1876, 1877, 1878, 1879, and 1880 the average annual value of coastwise imports amounted to $390,000.		
The years 1881, 1882, 1883, 1884, and 1885 show an average annual value of $325,000.		
During the first six years the number of steamers trading between points up the river—Brunswick, Savannah, and Darien—touching at Darien on an average two hundred and forty times a year, with a gross average tonnage of 63,000 tons per annum.		
Now about one hundred and fifty landings are made, and the average tonnage amounts to about 40,000 tons annually.		
Farm products:		
The annual value of the farming industry is estimated at $7,000. All farm products are disposed of at home	7,000 00	
Value of the stevedore business:		
1875, $92,787; 1876, $129,057; 1877, $139,275; 1878, $125,745; 1879, $104,550; 1880, $161,512; 1881, $151,258; 1882, $97,828; 1883, $102,826; 1884, $116,170; 1885, $92,189. Showing the total value for the eleven years to be		1,313,197 00
Value of the towage business:		
1875, $19,875; 1876, $24,766; 1877, $27,452; 1878, $25,165; 1879, $21,400; 1880, $23,763; 1881, $32,957; 1882, $24,548; 1883, $22,987; 1884, $22,151; 1885, $18,439. Showing the total value for the eleven years to be		263,503 00
Value of the pilotage business:		
Pilotage on foreign vessels for last eleven years amounted to .. $109,509		
Pilotage on coastwise vessels for last eleven years amounted to. 82,250		191,759 00

GENERAL REMARKS REGARDING THE COMMERCE OF THE PORT OF DARIEN, GEORGIA.

The timber trade.

So far as inclosed official figures of exports tell the tale, our timber trade is on the decrease. Actually it is not. As much timber as ever comes down to Darien from the interior, but the shallowness of water on our bar makes it necessary to ship a large part of our timber to Sapelo and Saint Simon's. While the cost of sending timber from Darien to Doboy is from 12½ to 15 cents per thousand feet, the cost of sending it to Sapelo and Saint Simon's is from 25 to 30 cents per thousand. It is easy to see that this disadvantage alone will do much to exclude us from competition with other pitch-pine ports which have no such disadvantages to contend with. Such shipments also, being cleared through the custom-houses of Savannah and Brunswick, go to swell their exports, and Darien, in consequence, finds it a hard matter to secure anything like the recognition she deserves. The presence of such vessels in our own harbor would materially increase our general trade and add to the importance of the port. While so far all these disadvantages have not dealt any serious blow to the interior timber trade, they certainly have prevented its natural growth and with it the growth of our commerce generally.

For the last five years from 15 to 25 vessels of a large class have annually loaded with Darien timber at Sapelo and Saint Simon's, but the quantities and values of these cargoes are recorded in the custom-houses of Savannah and Brunswick and claimed as amongst their exports. The figures submitted in this report are strictly shipments from our own harbor.

Arrivals and clearances of vessels at Darien, Ga., from January 1, 1875, *to January* 1, 1886.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.			Greatest draught.
				American vessels.			Foreign vessels.						
	No.	*Tons.*	*Crew.*	*No.*	*Tons.*	*Crew.*	*No.*	*Tons.*	*Crew.*	*No.*	*Tons.*	*Crew.*	*Feet.*
1875	77	28,063	647	....	....	......	92	47,600	1,198	169	75,663	1,845	22
1876	65	23,105	611	....	....	......	124	70,368	1,897	189	93,473	2,508	21
1877	104	54,827	1,257	3	674	23	99	50,913	1,231	206	106,414	2,510	20
1878	61	29,264	641	2	1,051	20	126	60,109	1,628	189	90,424	2,289	20
1879	58	23,275	487	3	1,199	25	115	57,710	1,407	176	82,184	1,919	19½
1880	66	21,539	489	1	668	13	134	68,072	1,608	201	90,279	2,110	19½
1881	101	40,619	849	3	1,220	29	162	84,456	1,991	266	126,295	2,869	19½
1882	117	48,208	999	1	453	9	90	51,421	1,155	208	100,082	2,163	19
1883	95	38,173	815	....	....	......	93	49,790	1,135	188	87,963	1,950	19
1884	81	34,412	714	2	606	16	92	50,178	1,133	175	85,196	1,863	19
1885	78	27,763	682	2	652	16	80	42,587	975	160	71,002	1,673	18½

CLEARED.

Year.	Coastwise.			American vessels.			Foreign vessels.			Total.			Greatest draught.
1875	22	12,214	328	11	4,055	97	104	55,759	1,372	137	72,028	1,797	22
1876	39	9,300	270	4	1,553	82	180	87,489	2,263	223	98,842	2,565	21
1877	44	13,209	314	4	842	21	169	92,795	2,154	217	106,846	2,489	20
1878	28	7,842	181	6	3,009	62	149	83,885	1,947	183	94,236	2,190	20
1879	40	14,052	301	7	2,765	57	125	65,433	1,538	172	82,250	1,896	19½
1880	55	17,076	393	7	3,589	72	168	84,172	2,016	230	104,837	2,481	19½
1881	80	28,492	617	8	3,120	70	184	95,353	2,164	272	126,965	2,851	19½
1882	93	34,098	709	6	1,962	46	115	63,525	1,434	214	99,585	2,189	19
1883	66	25,019	519	9	3,533	72	108	56,411	1,340	183	84,963	1,931	19
1884	59	20,637	457	11	3,977	85	119	66,337	1,478	189	90,951	2,020	19
1885	46	16,649	339	8	3,354	62	98	52,742	1,198	152	72,745	1,599	18½

Timber shipments from Port of Darien, Ga., from January 1, 1875, *to January* 1, 1886.

Year.	Foreign.		Coastwise.		Total.	
	Number of superficial feet.	Value.	Number of superficial feet.	Value.	Number of superficial feet.	Value.
1875	41,447,024	$557,524	10,992,600	$181,377 00	52,439,624	$738,901 00
1876	60,762,000	735,099	8,870,000	138,105 00	69,182,000	873,204 00
1877	64,378,000	776,856	11,888,100	196,153 65	76,266,100	973,009 65
1878	59,697,124	716,363	7,057,800	116,453 70	66,754,924	832,818 70
1879	47,217,818	566,613	12,646,800	208,672 20	59,864,618	775,285 20
1880	74,612,520	895,350	15,368,500	253,578 60	89,981,020	1,148,928 60
1881	65,420,876	785,050	25,642,800	423,105 20	91,063,676	1,208,156 20
1882	36,639,379	439,672	30,688,200	506,855 30	67,327,579	946,027 30
1883	42,385,000	508,620	22,517,100	371,532 15	64,902,100	880,152 15
1884	50,656,000	607,872	18,573,300	306,459 45	69,229,300	914,331 45
1885	40,101,000	501,262	14,984,100	247,937 65	55,085,100	749,199 65
	583,316,741	7,090,283	178,729,300	2,949,730 90	762,046,041	10,040,013 90

COMMERCE.

Year.	Value of exports.	Value of imports.	Total collections.
1880	$1,621,904	$5,600	$11,806 72
1881	1,187,496	3,356	18,980 02
1882	1,073,008	1,025	11,254 19
1883	969,834	2,334	11,067 37
1884	1,038,185	11	9,688 20
1885	860,500	....	2,859 01

R. W. GRUBB,
Deputy Collector, Port of Darien.

First Lieut. O. M. CARTER,
Corps of Engineers, U. S. A.

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IMPROVEMENT OF BRUNSWICK HARBOR, GEORGIA.

The appropriations made by Congress since 1879 for improving Brunswick Harbor, Georgia, in conformity to the original project described in my annual report of 1880, printed as Appendix J 7, Annual Report of the Chief of Engineers for the same year, aggregate $70,000. Previously an appropriation of $10,000 had been made by the act approved July 4, 1836, and expended in partially removing a shoal in the same locality at which improvements have recently been made.

The project referred to provided for the construction of a jetty or training-wall, projecting from the most easterly point of Buzzard's Island, located approximately parallel to and about 1,000 feet distant from the opposite shore of Brunswick River (East River), for the purpose of contracting the water-way and concentrating the currents. The project further provided for more or less dredging along the line of channel proposed to be improved. The cost of the project was estimated at $73,187.

The object of these operations is to establish and maintain a ship-channel of 15 feet depth at mean low water, equivalent to about 22 feet at mean high water, through the shoal located about a mile below the city of Brunswick, where heretofore there existed a low-water depth of only 9 feet. No estimates were included in this plan for works at the upper end of Buzzard's Island or elsewhere that might eventually be necessary for increasing the ebb flow of Brunswick River. The possibility that such works might be needed was suggested in my first annual report on this improvement, where I stated that it was determined to omit all work at the upper end of the island as a matter for future consideration.

It has been evident for some years past that the existing project must be modified, or rather enlarged, in order permanently to secure the lowering of the refractory shoal to a minimum low-water depth of 15 feet.

The enlarged plan embraces the work contemplated in the existing project, and provides, in addition, for the following work:

(1) A low dam across Turtle River, extending obliquely up-stream from the upper end of Buzzard's Island to the opposite shore of Blythe Island. This dam is designed to deflect a larger volume of water at ebb tide into Brunswick River, and thus increase the strength of the currents across the shoal below the city of Brunswick.

(2) Dredging in the vicinity of Turtle River Dam to facilitate the entrance of a larger amount of water into Brunswick River.

(3) Short spur-jetties in the lower part of the river, either on the right or left bank, or on both banks, to contract the water-way. When the location of the existing jetty was fixed, it was expected that this work, in conjunction with the proposed line of bulkhead on the opposite or city shore, would cause the necessary contraction, in order that the currents might produce the desired scouring effects upon the shoal below. The bulkhead line, which it was presumed would be built either by the city authorities or by the riparian owners directly interested in the improvement of the ship-channel, exists as yet only upon paper. Only the heads of a number of piers of open pile-work approximately indicate the bulkhead line.

The effects which a bulkhead would have aided in producing may be realized to a satisfactory extent by the construction of spurs. For some distance above the return-face of the existing jetty the width of the river may advantageously be somewhat reduced by building a few wing-dams from Buzzard's Island, or by extending the jetty up-stream a few hundred yards.

(4) *Jetty.* This work to be raised to a higher and uniform level.

(5) *Dredging on the shoal in Brunswick River.* In the original plan it was estimated that 90,000 cubic yards of material would have to be removed at a cost of $17,750. Experience has shown that a larger expenditure will be required for this purpose, the refractory character of a large portion of the material consisting of compact clay or shell-stone, greatly increasing the cost of dredging in the first instance, and the quantities to be removed largely exceeding those originally estimated, owing to the fact that in the absence of sufficiently strong currents the dredged cuts were repeatedly partly filled in again during the time that work was suspended from want of funds.

It is estimated that the enlarged plan, herewith briefly described, will in the aggregate cost from $190,000 to $200,000, inclusive of the amounts heretofore appropriated.

DESCRIPTION OF WORK DONE IN BRUNSWICK HARBOR, GEORGIA, IN ACCORDANCE WITH EXISTING PROJECT OF IMPROVEMENT.

With the usual intermissions, rendered unavoidable by irregular and inadequate appropriations, operations have been carried on from October, 1880, to May, 1885.

There being no funds available, no work was done during the past fiscal year.

The main line of the jetty is now laid to a length of 4,199 feet. Its head reaches the 18-foot low-water curve of Turtle River. Its upper end is located some distance off the projecting point of the east shore of Buzzard's Island, and is joined thereto by a spur or return-face of 310 feet length. The return-face and the adjoining portion of the jetty proper are formed of palmetto cribs, attached to platforms of round timber, and filled with brush and dredged material. To insure the stability of the spur, an apron of log-and-brush mattresses, 30 feet wide, held down by riprap-stone, is placed on the down-stream side along the base of the cribs. Several courses of similar matresses, 20 feet wide, rise up to the top of the cribs, and additional courses of mattresses and riprap-stone placed on top of this submerged work bring its crest up to a height of 2 or 3 feet above mean low water. On the up-stream side of the spur its base is likewise protected from scour by mattresses.

Crib-work, topped off with a ridge of riprap-stone, forms 780 linear feet of the length of the jetty proper, beginning at the angle formed with the return-face. The low-water depths next to the line of cribs, spur, and jetty, range from 10 to 18 feet. The remaining portion of the jetty, 3,419 linear feet, is built of double-raft mattresses, overlaid with brush and loaded with riprap-stone, averaging 4 feet in thickness over all; they occupy generally more shallow water, varying from 4 to 9 feet, except in approaching the head of the work, where the water rapidly deepens. The bottom mattresses are 30 feet wide, excepting the last two, which are 40 feet.

The material removed by dredging—sand, loam, and clay, mixed in various proportions—aggregated 80,502 cubic yards. The dredging was carried on upon four adjoining lines, parallel to the jetty and about 240 yards east of it. Each cut varies from 20 to 25 feet in width; they commence a little above the point of the junction of the jetty with its return-face. They were for the most part made to a low-water depth of 15 feet; the longest cut measured 4,840 feet, reaching the 15-foot low-water curve of Turtle River. Its upper portion, for a length of about 1,000 feet, was only dug to a depth of 12 feet. Two other cuts of 15 feet depth, and each about 4,400 feet in length, approached the outer 15-foot curve, while the fourth cut, of 12 feet depth, extended only about 1,500 feet down-stream from the upper end. The depths of water at low tide on either side of the line and in the vicinity ranged from 8 to 11 feet at the time when the dredging was done.

PRESENT CONDITION OF THE WORKS OF IMPROVEMENT, AND OF BRUNSWICK RIVER IN THEIR VICINITY.

The jetty is in good condition; the riprap-stone covering of the cribs and mattresses is well cemented together by oyster-shells and barnacles.

No dredging has been done since April, 1883, and in the absence of works required for controlling and strengthening the ebb currents, the depths gained at that time have to a great extent been lost, although the channel at the shoalest places is still from 1 to 2 feet deeper than before the improvement was commenced. Some shoaling has taken place along the city front from Dartmouth street, opposite the upper end of the jetty, to a point about 800 yards higher up. The river is here from 100 to 200 yards wider than either above or below. Aside from the width of the river, which should be somewhat reduced, the shoaling referred to may also be ascribed to the fact that vessels up to 200 feet in length are frequently moored bow on at the wharves of this reach. For a portion of their lengths they thus act as spur-jetties, tending to throw the currents across the river towards the upper end of the jetty, while shoaling ensues at the inner ends of the vessels, gradually extending outward. At the upper part of the city, where the river is but 200 yards wide, ample depths exist for any vessels that can cross the sea-bar at high tide, which suggests the expediency of narrowing the river just above the upper end of the existing jetty by some wing-dams.

With any funds that may become available it is proposed to raise the existing jetty to a higher level, and to begin the work of improvement at the upper end of Buzzard's Island, in accordance with the enlarged project.

The population of the city of Brunswick is rapidly increasing. In 1870 it was 2,100; in 1880, 2,900; in 1884, 5.500; and now it is estimated at 6,000. The city is easily accessible from the sea, with a practicable mean low-water depth of 16 to 17 feet on the bar, equivalent to about 23 feet at mean high water.

From the second Trade Issue, Brunswick, December, 1885, a commercial periodical considered to be well informed on the business of the city, it appears that in 1885 the shipments of timber, foreign and coastwise, aggregated 89,750,000 feet, valued at $1,231,282. In the same year the export of naval stores is said to have amounted to 87,453 barrels of rosin, and 891,863 gallons spirits of turpentine, of a total value of $565,502. Of another staple article, cotton, 21,788 bales were shipped, all coastwise, of an estimated value of $1,080,000. In each of the years 1883-'84, and 1885 the aggregate value of goods exported exceeded $3,000,000, and averaged $3,333,653. In previous years the value of exports was considerably below that average.

Brunswick is directly connected with the interior of the State of Georgia by two railroads: the Macon and Brunswick Railroad and the Brunswick-Albany Railroad. Both lines traverse vast tracts of timber land, and they are expected before long to connect with other railroads to form continuous lines of transportation with the western sections of country drained by the Mississippi. The prospects are that the city of Brunswick will continue to increase in population and commercial importance, and it seems desirable that Government should supply as early as possible the funds required to remove the obstructions to navigation below the city wharves.

This improvement is located in the collection district of Brunswick, Ga., at the port of entry. Amount of import and other duties collected in 1885, $3,939.27.

Since the present plan of improvement was adopted appropriations have been made as follows:

By act of Congress approved March 3, 1879	$20,000
By act of Congress approved June 14, 1880	10,000
By act of Congress approved March 3, 1881	5,000
By act of Congress passed August 2, 1882	25,000
By act of Congress approved July 5, 1884	10,000
Total	70,000

Of this amount there has been expended to June 30, 1886, the sum of $69,871.81.

A chart of Brunswick Harbor, showing condition of improvement to June 30, 1886, and the report of First Lieut. O. M. Carter, Corps of Engineers, including commercial statistics by the collector of the port, are herewith transmitted.

Money statement.

July 1, 1885, amount available		$387
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$125 47	
July 1, 1886, outstanding liabilities	133 77	
		259
July 1, 1886, amount available		128
Amount appropriated by act approved August 5, 1886		22,500
Amount available for fiscal year ending June 30, 1887		22,628
Amount (estimated) required for completion of existing project		97,500
Amount that can be profitably expended in fiscal year ending June 30, 1888		75,000

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

REPORT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., June 30, 1886.

GENERAL: I have the honor to submit the following report of operations for i proving the harbor at Brunswick, Ga., for the fiscal year ending this date:

On account of lack of funds no work was done here during the year. An examin tion made during the present month shows the jetty to be in good condition, the ro being well cemented together by oyster shells and barnacles.

During the year a few wharves have been built out beyond the authorized bul head line. This, together with the method of mooring vessels at right angles to t wharves, has caused some shoaling along the city front. The 9-foot curve abo McCullough's Wharf has pushed out almost to the sailing range, and the channel d fined by these curves has narrowed 150 feet during the year. The 12-foot mean lo water channel at the lower end of the city has narrowed somewhat, and does n extend up-stream as far by 375 feet as at the close of last year. Opposite the upp end of the jetty the channel defined by these curves has widened, increased in reg larity, and worked down-stream in places about 350 feet. The shoal middle grou has almost disappeared.

The length of the shoal between the upper and lower 2-fathom curves is now 2,6 feet, with a least mean low-water depth on the range of 10.1 feet, a shoaling of ha a foot having taken place during the year.

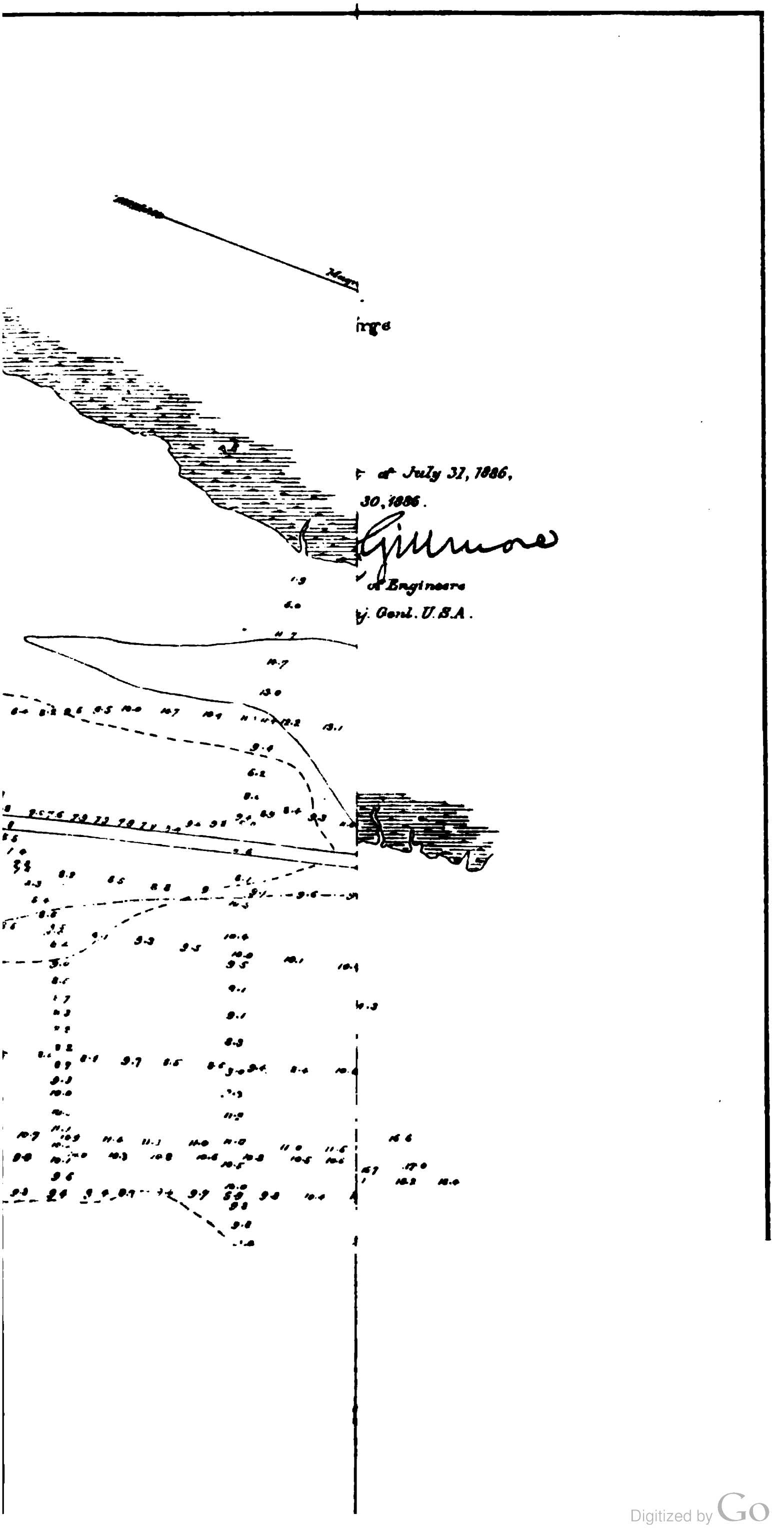
I append a table of commercial statistics of the port, furnished by the collector customs. The exports have increased from $693,000 in 1875 to $3,063,960 in 188 The shipments of lumber, coastwise and foreign, during the year of 1885 amounted 89,750,000 feet. The trade in naval stores has almost trebled in the last 5 years, th foreign shipments during this period having increased at a still greater rate. In 18 only four vessels were required to carry the naval stores shipped foreign, while i 1885 twenty-eight vessels were required to carry the 84,983 barrels of rosin an spirits of turpentine exported.

A chart showing the present condition of the improvement is transmitted herewith

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieutenant, Corps of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.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COMMERCIAL STATISTICS.

Arrivals and clearances of vessels, and commerce, at Brunswick, Ga., from January 1, 1878 to December 31, 1885.

ARRIVED.

Years.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	Vessels.	Tonnage.	Crew.	Vessels.	Tonnage.	Crew.	Vessels.	Tonnage.	Crew.	Vessels.	Tonnage.	Crew.
1878	116	32,584	850	36	10,218	270	41	19,008	498	193	61,810	1,618
1879	148	44,397	1,090	33	8,235	232	40	17,589	468	221	70,221	1,790
1880	271	77,656	1,892	36	11,219	317	39	14,996	432	346	103,871	2,641
1881	279	100,451	2,239	13	4,174	98	63	30,279	751	355	134,904	3,088
1882	335	123,149	2,659	7	2,095	57	63	26,958	694	405	152,202	3,416
1883	299	110,302	2,368	11	4,814	107	87	40,765	979	397	155,881	3,454
1884	239	88,063	1,293	10	4,434	88	126	62,818	1,435	375	155,315	3,416
1885	242	93,280	1,928	10	3,216	97	94	43,284	1,037	346	139,780	3,052

CLEARED.

Years.	Vessels.	Tonnage.	Crew.	Vessels.	Tonnage.	Crew.	Vessels.	Tonnage.	Crew.	Vessels.	Tonnage.	Crew.
1878	124	32,767	874	28	9,231	236	49	21,218	550	201	63,216	1,660
1879	157	42,345	1,116	21	7,172	172	47	21,730	555	225	71,247	1,843
1880	270	78,913	2,010	14	5,010	115	48	19,970	550	332	103,900	2,675
1881	252	82,155	1,732	17	7,218	156	87	42,659	1,014	356	132,032	2,902
1882	278	96,170	2,086	19	7,761	170	101	48,699	1,139	398	152,630	3,395
1883	257	91,036	1,962	28	11,268	240	124	55,717	1,369	411	158,021	3,571
1884	176	62,927	1,322	38	16,209	335	148	70,612	1,638	362	149,748	3,290
1885	196	71,345	1,481	21	8,696	190	135	62,437	1,456	352	142,478	3,127

COMMERCE.

Years.	Value of exports.	Value of imports.	Total collections.
1878	$1,372,842	$400	$4,500 97
1879	1,394,401	3,197	5,644 33
1880	1,702,570	3,098	17,723 27
1881	2,230,000	4,377	29,305 30
1882	2,700,000	2,739	20,056 90
1883	3,437,000	3,008	24,911 61
1884	3,500,000	958	19,730 82
1885	3,063,960	4,008	3,939 27

Comparative statement of receipts and shipments of naval stores.

Years.	Receipts (barrels).						Shipments (barrels).							
	Stock on hand.		Receipts for year.		Total.		Coastwise and interior towns.		Foreign.		Stock on hand.		Total.	
	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.
1880	3,000	600	36,495	8,661	39,495	9,261	29,339	8,371	7,201	650	2,935	240	39,475	9,261
1881	2,935	240	67,362	13,490	70,297	13,730	37,029	8,621	18,077	3,009	15,191	2,100	70,297	13,730
1882	15,191	2,100	104,357	23,459	119,548	25,559	46,785	11,533	52,972	11,826	19,791	2,200	119,548	25,559
1883	19,791	2,200	80,078	16,105	99,769	18,305	9,846	5,183	74,687	12,229	15,236	893	99,769	18,305
1884	15,236	893	105,622	23,449	120,858	24,342	22,859	2,565	89,983	20,167	8,016	1,610	120,858	24,342
1885	8,016	1,610	92,958	20,900	100,974	22,510	20,197	3,556	68,814	16,169	11,963	2,785	100,974	22,510

JACOB E. DART,
Collector.

First Lieut. O. M. CARTER,
Corps of Engineers, U. S. A.

M 13.

IMPROVEMENT OF THE ENTRANCE TO CUMBERLAND SOUND, BETWEEN GEORGIA AND FLORIDA.

The plan for the improvement of the entrance to Cumberland Sound, Georgia and Florida, submitted with my report of June 30, 1879, printed as Appendix I 8, Annual Report of the Chief of Engineers for 1879, comprises the construction of two low jetties composed of riprap-stone resting upon a foundation mattress of logs, or logs and brush, starting, respecttively, from the shores on opposite sides of the entrance and extending seawards across the bar upon lines so directed that the outer ends will be parallel to each other and from 3,000 feet to 3,500 feet apart, or such distance as may hereafter be deemed necessary. The available low-water depth has heretofore varied from 11 feet to 13 feet, with a mean rise and fall of tides of about 6 feet. Two low jetties reaching entirely across the bar would be expected to maintain a low-water channel not less than 20 to 21 feet deep. Greater depth may be secured by carrying the jetties to higher levels.

The cost of the work was estimated at $2,071,023.

On account of the small appropriations hitherto made for this improvement, entirely disproportionate to its magnitude, and the frequent and prolonged suspension of operations resulting therefrom, this original estimate of cost will probably be considerably exceeded.

Four appropriations have thus far been made for improving the entrance to Cumberland Sound, aggregating $255,000.

No work was done on the jetties during the fiscal year just closed, no funds being available for the purpose.

SUMMARY OF WORK DONE TO THE PRESENT TIME.

North jetty.—This work was commenced in June, 1881. From its shore end on Cumberland Island, the foundation course or apron, consisting of log and brush mattresses overlaid with broken stone, extends 2,200 feet on a range bearing south 63½ degrees east, crossing Cumberland Channel. It then follows a range bearing south 80 degrees east for a length of 5,172 feet. The total length of the apron is therefore at present 7,372 feet. Its seaward end is located in shallow water, not far from the North Breakers, north of Pelican Shoal. The mattresses are from 25 to 52 feet wide, and from 19 to 22 inches thick. At the deeper portions of Cumberland Channel, for a length of 1,493 feet, a second course of mattresses, 20 feet to 25 feet wide, rests upon the bottom course. Here the foundations for two spurs were also laid on the south side of the jetty. Thus far 15,612 cubic yards of riprap stone have been used in the work.

South jetty.—The south jetty was commenced in June, 1882. Its starting point is located on the eastern shore of Amelia Island, about 5,700 feet from Fort Clinch. The bottom course has been laid to an aggregate length of 7,667 feet, the mattresses varying from 40 to 100 feet in width. The jetty, from its starting point on Amelia Island, follows a course due east for a distance of 1,619 feet. Thence it is laid for the balance of the length of bottom course so far constructed, upon a range north 68 degrees 32 minutes east. The mattresses are about 18 inches thick, and are loaded with an average of 12 inches of stone. For about half a mile the jetty is laid in comparatively shallow water; the rest of the work, extending seaward, passes through water of from 17 to 20 feet depth at mean low tide.

The south jetty has at present reached a point upon the inner slope of the bar whence another more easterly range will be adopted, when operations can be resumed.

The following quantities of material have been employed in the work from the beginning of operations to the present time:

	Mattresses.	Riprap-stone.
	Square yards.	*Cubic yards.*
North jetty	46,480	15,612
South jetty	74,170	23,280
Total	120,650	38,892

The lengths of the foundation courses of the two jetties, measured along their axes, are as follows:

Length of foundation course of north jetty, June 30, 1886, 7,372 feet.

Length of foundation course of south jetty, June 30, 1886, 7,667 feet.

EFFECTS AND CONDITION OF THE WORKS OF IMPROVEMENT.

A survey of the entrance to Cumberland Sound was made in July and August, 1885, a chart of which, with my report, dated November 28, 1885, has been submitted to the Department. An additional examination was made in June, 1886.

These investigations disclosed some interesting facts when comparing their results with those furnished by a survey made in April, 1883.

Over large portions of the bar, where the new ship channel is to be located, the depth of water has increased. The 18-foot low-water curve on the inner slope of the bar, actually a pocket formed by the eastward continuation of the marginal 18-foot curves of Amelia Basin, was, in August, 1885, found to have worked out about 3,000 feet since 1883, but in June, 1886, had again receded 1,350 feet, so that at that time the actual advance since 1883 amounted to about 1,650 feet, extending to a point about one-fourth of a mile in advance of the present outer end of the south jetty.

Compared with its location in 1883, the outer 18-foot curve, beyond the crest of the bar, had in August, 1885, receded from 350 to 400 feet, but in June, 1886, it had again moved seaward from 75 to 220 feet. In consequence of these changes the nearest distance between the inner and outer 18-foot curves of the bar was 4,000 feet at the end of the last fiscal year, while in April, 1883, it exceeded one mile.

Although at the present time the hydraulic condition of that portion of the bar where the new permanent ship-channel will be located is not as favorable as during the first months of the past fiscal year, it is evident that depths have generally increased, and the inner 18-foot curve has advanced about 550 yards nearer to the bar-crest since 1883, forming a pocket in conformity to the line of channel designed to be created. This result may well be ascribed in a large measure to the recent seaward extension of the foundation of the south jetty, which has amounted to over 3,500 feet since December, 1884.

The Pelican and other shoals to the north of Amelia Basin have shifted their position to the eastward; their aggregate area exposed at low-water in August, 1885, was considerably less than in 1883.

The local deepening of Cumberland Channel, where it is crossed by the north jetty, has continued. In 1881, before the work of improvement had been commenced, the maximum low-water depth was here 12½ feet. In 1883, when the bottom course of the jetty had already attained its present length, depths of from 16 to 17 feet had developed on either side of and near to the work. The survey of 1885 showed further increase of depth, chiefly to the southward, where up to 23 feet of water was found in the month of August of that year. This is actually merely a deep pool which rapidly becomes more shallow in going further south; it probably owes its origin to the water combing over the submerged jetty at flood-tide. A settlement of about 5 feet has taken place here; this matter must be attended to as soon as funds shall become available.

The shore-ends of both jetties are well sanded over, and the shore-lines in their vicinity are steadily growing seawards, especially at the south jetty, where since September, 1885, the low-water line has advanced about 1,000 feet, and "Kingsley's Bank" is now practically joined to the shore.

The portions of the north jetty bare at low-water are in good condition, the stone covering being well compacted by the growth of barnacles. Where logs of mattresses are exposed, the work of the teredo can be observed, but no material damage seems to have been done. The mattresses of the south jetty, laid in 1884 and 1885, have sanded over well.

The 12-foot and 18-foot curves forming the margins of the deep anchoring ground known as Amelia Basin have not materially changed their positions of late years, except that at a point about 2,000 feet southeast of the present seaward end of the north jetty the northern marginal 12-foot curve now bulges out northward, forming a pocket from 1,200 to 1,500 feet long. The pocket is located upon the site of a shoal which was formerly bare at low water or had depths of from 1 foot to 4 feet. Further north, on the range of the pocket, the deepest water in this vicinity is found, and it is possible that a new channel may be formed here that will ultimately take the place of Cumberland Channel when the latter shall have been obstructed by raising the crest of the north jetty, unless it is prevented by an early extension of the jetty.

Noticeable changes in the sailing line across the bar are to be recorded. In 1880, vessels approaching from the sea followed a course bearing west-southwest, practically parallel to the second range upon which the south jetty was since laid, and about 1,200 feet to the northward of it. In 1881, however, the line in approaching the bar had a direction almost due west until it intersected, somewhere in the vicinity of the crest of the bar, the line of 1880, which the vessel then followed. The bar-channel, therefore, formed an obtuse angle opening southward. In 1883 the channel had again straightened out, but had traveled about 200 feet southward, with nearly the same bearing as in 1880. It remained in that position for over two years, but in September, 1885, another southward movement was observed, parallel to the former direction and approaching the south jetty to within from 800 to 880 feet, still running a straight course.

In April, 1886, another change occurred, similar in character to that which took place in 1881. The sailing line on the inner slope of the bar had moved still further south, and was then about 600 feet north of the present seaward end of the jetty, but on the crest of the bar it formed an angle, passing almost due east across the outer bar-slope into deep water. If the jetty were extended on its present range about 1,000 yards, it would intersect the outer leg of the angle of the sailing line.

A strong ebb current sets to the southeast across the south jetty, which has settled somewhat at the angle formed by its two range lines.

It is evident that the extension of both jetties should be proceeded with vigorously to promote the connection of the 18-foot curves on the inner and outer slopes of the bar, and to prevent the channel of navigation from shifting from place to place. By comparison with the chart of 1843 the length of the bar channel between the 18-foot curves has diminished 4,500 feet, and its least practicable depth has increased 1 foot; the shoalest low-water sounding in the present range is now 14 feet, whereas heretofore 13 feet was the greatest available depth.

With any funds that may become available, it is proposed to extend the foundation-course of the jetties and raise them to a higher level, and to protect by suitable works the north jetty from undermining by scour where it crosses the deep portion of Cumberland Channel.

The advantages possessed by the port of Fernandina, on account of its large capacity and well-sheltered anchorage, have been referred to in previous Annual Reports. Attention is invited to the commercial statistics appended to the accompanying report of my assistant, First Lieut. O. M. Carter, Corps of Engineers. It appears from them that the total commerce of the harbor of Fernandina during the eleven years ending December 31, 1885, was valued at $31,940,235.

This work is located in two collection districts, the north jetty being in the collection district of Saint Mary's, Ga., and the south jetty in that of Fernandina, Fla. Fernandina is the nearest port of entry. Import duties collected during the year 1885, $2,451.

The following appropriations have been made for the improvement of the entrance to Cumberland Sound:

By act of Congress approved June 14, 1880	$30,000
By act of Congress approved March 3, 1881	100,000
By act of Congress passed August 2, 1882	50,000
By act of Congress approved July 5, 1884	75,000
Total	255,000

The expenditures to June 30, 1886, aggregated $254,235.36.

Since the cost of the approved project is estimated at $2,071,023, an aggregate sum of $1,816,023 remained to be provided for by appropriations on July 1, 1886.

A chart of the entrance to Cumberland Sound showing condition of the improvement to June 30, 1886, and the report of First Lieut. O. M. Carter, Corps of Engineers, with commercial statistics furnished by the collector of the port of Fernandina, are herewith transmitted:

Money statement.

July 1, 1885, amount available		$3,698 31
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$2,566 69	
July 1, 1886, outstanding liabilities	366 98	
		2,933 67
July 1, 1886, amount available		764 64
Amount appropriated by act approved August 5, 1886		112,500 00
Amount available for fiscal year ending June 30, 1887		113,264 64
Amount (estimated) required for completion of existing project		1,693,523 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		600,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

REPORT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., June 30, 1886.

COLONEL: I have the honor to submit the following report of operations for improving the entrance to Cumberland Sound, Georgia and Florida, during the fiscal year ending this date. On account of lack of funds no work was done on either jetty during the year.

During the months of July and August, 1885, a survey of the bar was made. This disclosed some important changes since the survey of 1883. In the vicinity of the north jetty the high-water line had advanced seaward from 200 to 290 feet, and the low-water line from 350 to 450 feet. Near the south jetty the high-water line had extended seaward from 200 to 220 feet, and the low-water line from 200 to 300 feet.

The shoals along the northern side of the channel had diminished in area, and had shifted to the eastward from 1,000 to 2,500 feet, one shoal, bare at low water, having formed near Station E (the north dome of the wreck of the City of Austin), where in 1883 there was a depth of from 10 to 15 feet of water.

Near the sea end of the north jetty the 2-fathom curve had pushed northward, forming a pocket about 1,500 feet long, where in 1883 there was only from 1 to 4½ feet of water. This same curve had moved southward near Station E about 500 feet, and had pushed in a northeasterly direction out over the bar. The inner 3-fathom curve had crossed the south jetty about 2,100 feet beyond the angle, and pushed to the southeastward about 2,350 feet. In the bar channel this curve had advanced seaward over 3,000 feet, while the outer 3-fathom curve had moved shoreward, encroaching on the bar from 350 to 400 feet. The outer bar-channel had moved to the southward 600 feet.

An examination made during the present month shows that the shore ends of both jetties are well sanded over. Those portions of the north jetty visible at low water are in good condition, the rock covering being cemented into a solid mass by shells, barnacles, &c. Where the logs are exposed they have been attacked by the teredo, but no sensible damage has been done to the work. The shore line is making out at the ends of both jetties. The low-water line near the south jetty has extended seaward since September about 1,000 feet, and "Kingsley's Bank" is now practically joined to the shore.

The Pelican and other shoals to the north of the channel have increased in area and have shifted their position since September, but time was lacking to instrumentally determine these changes. A strong ebb current now sets to the southeast across the south jetty, and some subsidence has occurred near the angle. The mattresses laid in 1884-'85 have, however, sanded over well, and an average shoaling of about 1 foot has taken place on this section of the jetty.

At a point about 1,700 feet from the shore end of the north jetty a settlement of about 5 feet has taken place. The rest of the jetty is in good condition.

On the northern side of the bar channel the 15-foot curve has moved to the southward since September about 1,200 feet. On the southern side of this channel it has moved in the same direction about 150 feet.

The inner 3-fathom curve does not extend out so far by 1,350 feet as in September, while beyond the bar this curve has moved seaward from 75 to 220 feet. The eastern end of the bar channel has shifted to the southward since September a distance of over 1,800 feet, measured along the outer crest of the bar, the rate of change in this direction being ten times greater than any hitherto known. The length of the bar channel between the 3-fathom curves has diminished by 4,500 feet since 1843 and its least depth has increased 1 foot. The shoalest low-water sounding on the new range is at present 14 feet, and vessels drawing 19 feet are being carried over the bar.

Commercial statistics of the port, furnished by the collector of customs, are appended hereto. Additional information concerning the commerce of the port, which will be forwarded directly to you, is being prepared by the receiver of the Florida Railway and Navigation Company.

A chart showing the condition of the jetties and the present depths on the bar is forwarded herewith.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieut. of Engineers.

Col. Q. A. GILLMORE,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels, and commerce at Fernandina, Fla., from January 1, 1875, *to December* 31, 1885.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1875	212	117,363	4,192	47	10,379	359	12	7,437	135	271	135,179	4,686
1876	210	141,354	4,749	25	4,893	179	28	9,232	249	263	155,479	5,177
1877	150	100,581	3,343	31	8,768	217	40	12,547	404	221	121,896	3,964
1878	183	120,845	3,900	17	3,985	101	22	8,294	215	222	133,124	4,216
1879	205	133,020	4,138	28	10,634	252	10	5,639	126	243	149,293	4,516
1880	270	146,722	4,470	34	22,396	598	22	9,463	240	326	188,581	5,308
1881	273	171,548	4,186	17	11,899	314	24	11,593	271	278	195,040	4,771
1882	239	146,383	3,279	16	9,056	242	15	6,639	151	270	162,078	3,672
1883	183	96,937	2,453	6	1,769	43	14	5,229	137	203	103,935	2,633
1884	176	105,061	2,864	3	865	21	10	4,029	88	189	109,955	2,973
1885	169	111,698	3,131	7	999	47	22	9,785	210	198	122,482	3,388

CLEARED.

Year.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1875	229	121,028	4,303	31	8,239	228	15	5,343	212	275	134,610	4,743
1876	244	161,154	5,058	21	6,040	147	26	9,002	269	291	166,196	5,474
1877	165	106,615	3,590	24	6,340	166	42	13,741	412	231	126,696	4,168
1878	195	124,883	4,086	19	4,911	123	26	9,080	236	240	138,874	4,445
1879	175	129,654	4,079	31	11,067	258	12	8,016	164	218	148,737	4,501
1880	244	155,659	4,505	31	14,207	327	24	10,202	240	299	180,068	5,072
1881	204	138,598	3,730	41	22,007	506	31	15,335	351	276	175,940	4,587
1882	217	136,666	3,166	39	15,497	370	31	14,962	321	287	167,125	3,857
1883	153	85,815	2,245	32	8,925	210	24	9,413	231	209	94,153	2,686
1884	178	104,462	2,688	27	8,831	176	15	6,488	158	210	119,781	3,022
1885	185	112,936	2,970	33	10,251	249	21	9,393	221	239	132,580	3,440

COMMERCE.

Year.	Value of exports.		Value of imports.		Total commerce.	Duties collected.
	Foreign.	Coastwise.	Foreign.	Coastwise.		
1875	$209,791	$1,109,979	$14,304	$755,718	$2,089,792	$1,817 84
1876	226,076	1,170,240	46,479	1,131,032	2,573,827	2,181 40
1877	310,225	676,855	19,304	1,146,363	2,152,747	2,376 00
1878	248,000	780,607	8,142	872,234	1,908,983	2,090 00
1879	275,470	921,368	11,038	1,360,432	2,568,308	3,424 00
1880	257,780	667,092	3,676	1,365,857	2,294,405	7,808 00
1881	292,100	1,064,394	11,791	1,736,546	3,104,831	8,183 00
1882	292,400	1,342,421	45,792	1,536,588	3,217,201	36,590 00
1883	248,600	2,573,010	11,229	2,262,755	5,095,594	5,566 00
1884	173,600	1,164,462	1,874	1,738,620	3,078,556	1,831 00
1885	214,726	2,134,541	4,180	1,502,544	3,855,991	1,451 28

W. A. MAHONEY,
Collector

First Lieut. O. M. CARTER,
Corps of Engineers, U. S. A.

M 14.

IMPROVEMENT OF INSIDE PASSAGE BETWEEN FERNANDINA AND SAINT JOHN'S RIVER, FLORIDA.

Appropriations for the improvement of this route, aggregating $78,000, were made at various times between the years 1828 and 1838. A further appropriation of $10,000 was made in 1874, and two others, of $7,000 each, by the acts approved March 3, 1879, and June 14, 1880, respectively.

Only $2,565.55 of the amount last appropriated had been expended when the work was stopped.

As suggested in previous reports, the recently completed direct line of railway between Fernandina and Jacksonville and the improvement of the bar at the mouth of Saint John's River afford passengers and freight a choice between transit by rail and transit by sea and river by coasting steamers, and the necessity for continuing the improvement of this inside passage is therefore not urgent at the present time; still the inside passage between Savannah and Jacksonville, which actually continues far into the interior of Florida by means of the Saint John's River, may be considered a valuable water route for many purposes. Its importance, in the case of the United States becoming involved in war with a maritime power, has been pointed out in former reports. Its improvement, when undertaken, should be on a liberal scale.

The following appropriations have been made for this work since 1874:

By act of Congress approved June 23, 1874	$10,000
By act of Congress approved March 3, 1879	7,000
By act of Congress approved June 14, 1880	7,000
Total	24,000

The total expenditures since 1874, including the cost of survey, were $19,565.55.

This inland route is partly in the collection district of Fernandina, and partly in that of Saint John's, of which Fernandina and Jacksonville are the respective ports of entry.

Money statement.

July 1, 1885, amount available	$4,434 45
July 1, 1886, amount available	4,434 45

APPENDIX N.

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATE OF FLORIDA.

REPORT OF LIEUTENANT WILLIAM M. BLACK, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Saint John's River, Florida.
2. Upper Saint John's River, Florida.
3. Volusia Bar, Florida.
4. Tampa Bay, Florida.
5. Apalachicola Bay, Florida.
6. Suwanee River, Florida.
7. Key West Harbor, Florida.
8. Pease Creek, Florida.
9. Harbor at Cedar Keys, Florida.
10. Manatee River, Florida.
11. Caloosahatchie River, Florida.
12. Apalachicola River, Florida.
13. Withlacoochee River, Florida.
14. Removing sunken vessels or craft obstructing or endangering navigation.

United States Engineer Office,
Jacksonville, Fla., July 28, 1886.

General: I have the honor to transmit herewith my annual reports upon the works of river and harbor improvement under my charge for the fiscal year ending June 30, 1886.

Very respectfully, your obedient servant,

W. M. Black,
First Lieut. of Engineers.

Brig. Gen. John Newton,
Chief of Engineers, U. S. A.

N 1.

IMPROVEMENT OF SAINT JOHN'S RIVER, FLORIDA.

Operations for improving the channel over the bar at the mouth of the Saint John's River, Florida, during the past fiscal year were carried on from the beginning of the year until September 23, 1885. The work was done under contract, and in accordance with the larger of two projects submitted to the Chief of Engineers by the officer then in charge, June 30, 1879, and printed as part of Appendix 17, Annual Report of the Chief of Engineers for 1879.

PROJECT OF IMPROVEMENT.

"The plan of improvement essentially consists in the construction of two low jetties, built of riprap-stone, supported by a foundation mattress or platform of logs, with a mattress hearting, wherever found practicable, to reduce the cost of the work.

Of the two plans discussed, which differed from each other in magnitude and probable effects, the more comprehensive one has been adopted. This plan provides for the construction of two long jetties, starting from the opposite shores of the entrance and extending seaward across the bar. It was intended thereby to establish a mid-channel depth of 15 feet at mean low water. The usual available low-water depth over the bar in its unimproved condition was 6 feet, more or less, with a mean rise and fall of tides of about 5 feet. The cost of this project was estimated at $1,306,409.

In order to secure the full benefit of an increased low-water depth on the bar, as contemplated by the project, it will be necessary to improve some defective reaches of Saint John's River between the bar and the city of Jacksonville, the cost of which has been approximately estimated at $120,000.

These additional works are considered to be properly the subject of a special project and appropriation. If it should be finally decided to include them under the general head, "Improvement of Saint John's River," the estimate of the cost of the project given above must be correspondingly increased.

Since the adoption of the existing plan of improvement of June 30, 1879, four appropriations have been made by Congress for the work, aggregating $525,000. Previously an aggregate sum of $57,476.28 was expended in dredging for the temporary improvement of the bar channel since 1865.

For making the preliminary surveys and preparing the project, the sum of $2,523.74 was expended."

SUMMARY OF OPERATIONS PRIOR TO JUNE 30, 1885.

South jetty.—The foundation course or apron was laid to an aggregate length of 6,715.4 feet. Of this, the shore branch is 874 feet long, with a bearing of N. 46, 45 E. The main line begins at a point 70 feet back from the outer end of the shore branch and runs as follows, viz:

	Feet.
Range 2 N., 74° 54′ E	3,538
Range 3 N., 75° 54′ E	328
Range 4 N., 77° 41′ E	400
Range 5 N., 79° 41′ E	400
Range 6 N., 81° 41′ E	400
Range 7 N., 83° 41′ E	400
Range 8 N., 85° 41′ E	373

On ranges 1, 2, 3, and a part of 4 the width of apron varies from 20 to 87 feet. In ranges 5, 6, 7, and 8 the width was increased to from 110 to 120 feet, on account of the rapid current already developed along the axis of the jetty. In all the apron is covered with from 12 inches to 15 inches of stone. At different points along the second range the following additional courses have been laid, viz: A second course, 3,209 feet long; a third, 2,729 feet long; a fourth, 1,544 feet long; a fifth, 1,317 feet long; a sixth, 903 feet long; a seventh, 127 feet long; an eighth, 134 feet long, and a ninth, 40 feet long. In general the mattresses of each course were eight feet narrower than those of the course below.

Eight low spur-jetties were constructed, four on each side of the jetty, opposite to each other. They are located at distances of from 500 to 1,800 feet, from the angle of the junction of the main line with the shore branch. These spurs are formed of two courses of mattresses, the lower ones projecting from 81 to 98 feet beyond the edges of the apron of the main line. Those laid on the north side are 75 feet wide, and those on the south side 100 feet wide. The original foundation course of the main line was widened to arrest the destructive action of very strong currents, developed alongside of and across the work. A revetment or apron of mattresses, varying in width from 40 to 100 feet, beginning at the low-water mark and extending 2,652 feet, was laid on the south side.

The foundation was still further broadened by placing a revetment or apron on the north side similar to that on the south. This revetment began at the second spur from the shore and extended seaward a distance of 1,703 feet, the width varying from 70 to 100 feet.

Between spurs 2 and 3, upon a length of 300 feet, there seems to be less stability than in the rest of the jetty. Here the greatest settlement has taken place, and as it had been built up as a wall with steep sides, it was further strengthened by a sort of buttress composed of log mattresses and riprap-stone, in all respects similar to the construction of the jetty. This buttress leans or abuts against the jetty for a distance of about 120 feet, parallel to the axis, and is formed of six courses of mattresses, the lower course being 35 feet wide and the top course 14 feet.

For holding the mattress work in place and in building up the south jetty, the amount of riprap stone employed from the beginning of operations to June 30, 1885, aggregated 66,344.5 cubic yards.

North jetty.—The total length of this jetty in place was 2,617.5 feet. The west end was extended shoreward 908 feet during the fiscal year 1884-'85, to fill a channel which had threatened to form around it. The jetty consists of a single course of mattresses 42 to 100 feet wide, covered by from 9 inches to 12 inches of stone, with its axis on a single range bearing S. 73 E.

Up to June 30, 1885, the total expenditures for both jetties, including outstanding liabilities, were $494,074.05.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

On July 1, 1885, the balance on hand available for work was $30,925.95.

Operations were continued under the contract with Mr. A. Ames Howlett, of Syracuse, N. Y., as stated in the Annual Report for 1885, at 75 cents per square yard for mattresses and $3.10 per cubic yard for stone. The mattresses were of the style described as "first design" in that report. Work was discontinued September 23, 1885.

South jetty.—Twenty-eight and ninety-three one-hundredths cubic yards of stone were placed on low parts of the jetty.

North jetty.—Fourteen mattresses, with an aggregate length of 1,339 feet and a width of from 50 to 100 feet, were placed in the line of the jetty, to which must be added 374 feet of shore protection. These were ballasted with 3,910.98 cubic yards of stone.

In June, 1886, the annual survey of the bar was made by Mr. A. W. Barber, assistant engineer.

From the commencement of the fiscal year the work was under the charge of Capt. W. T. Rossell, Corps of Engineers, until he was relieved by me April 26, 1886, by virtue of paragraph 2, Special Orders No. 89, Headquarters of the Army, Adjutant-General's Office, Washington, April 16, 1886.

CONDITION OF THE WORK JUNE 30, 1886, AND EFFECTS ON THE BAR.

The south jetty has a length of 836 feet completed to an average height of 2 feet above mean low water, and a total length of 6,715.42 feet.

The north jetty has a length of 374 feet, with an average height of 18 inches above mean low water, and a total length of 4,330.74 feet.

A comparison of the survey of 1886 with that of 1885 shows the following changes in the lines of the river and ocean:

South of the river the high-water line shows a more regular curve than it had last year. In the vicinity of the jetty it has receded about 140 feet, but is 75 feet outside the shore end of the jetty. Two thousand five hundred feet below the jetty it has pushed out about 150 feet. The low-water line on the south shore is practically unchanged.

On the north shore the high-water line has also receded. From Haulover Creek to the river the average amount of recession is 50 feet, from this point for 2,500 feet it is 250 feet, and near Fort George Inlet 25 feet. The shore end of the north jetty is now 200 feet outside high-water mark. The low-water line is practically unchanged, excepting at Fort George Inlet, where a large bank has made out from the shore.

The changes in the area inclosed by the 6-foot curve of the bar are very marked. This area formerly extended from the north shore across the jetty lines to the old ship-channel. It is now divided into three distinct parts, one south of the south jetty, one between the jetties, and the third north of the jetties.

The first is increasing, and apparently will cross the old ship-channel as soon as the sailing gap in the south jetty is closed.

The second lies across the jetty entrance, is bounded on the south by the new jetty channel and on the north by a channel running northeast across the end of the north jetty to deep water. This portion is very powerfully acted upon by what may be called the jetty currents. Its present tendency is to cut out on the north side and build up on the south, and it will all be moved eventually to make room for the jetty channel.

The third part is forming and protects the north jetty from the northeast storms.

In the present stage of its construction, the north jetty, while it protects somewhat the mouth of the river from encroachments of sand from the north, does not extend far enough to have much influence on the ebb currents from the river. It therefore assists in their constant tendency to straighten the channel at the river mouth, without properly directing them after passing that point. There is consequently a strong tendency to cut new channels across the line for the jetty extension, eroding the bottom and greatly increasing the height required for the completed work and its consequent cost. If work cannot soon be done here these false channels may even be a source of great injury to the ship entrance.

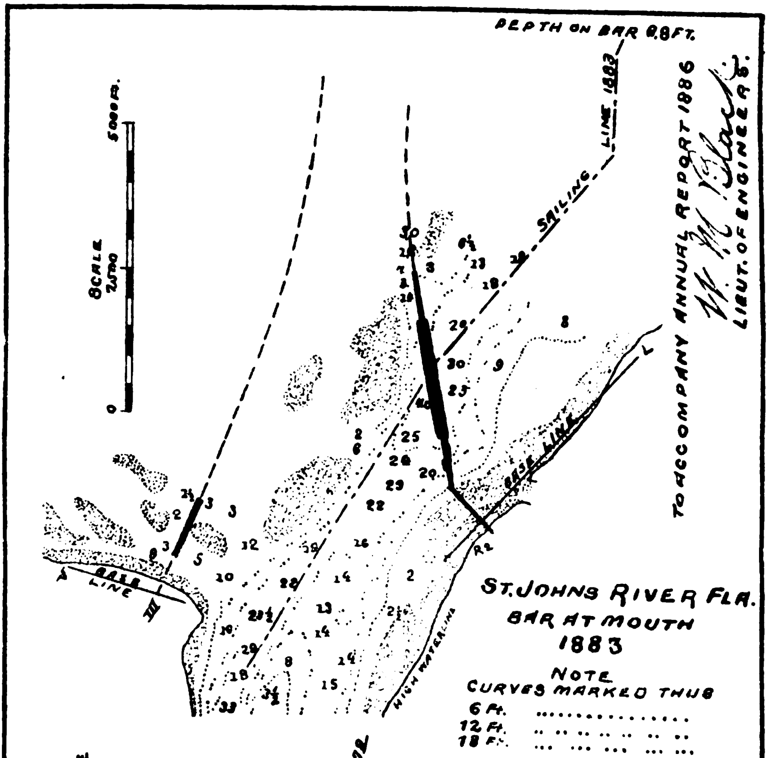
The 12 and 18 foot curves on the outer slope of the bar seem to have been pushed slightly seaward. The 24 and 30 foot curves follow the general trend of the coast.

The profile of the south jetty shows an average settlement of from 18 inches to 2 feet, probably caused by the partial destruction of the mattress hearting by the teredo. It has not been expected that this hearting could be preserved above the general sand-level. Beyond the shore extensions this may be expected to be, on the channel side of the jetties, at a depth nearly equal to the hydraulic mean radius of the improved

TO ACCOMPANY ANNUAL REPORT 1886

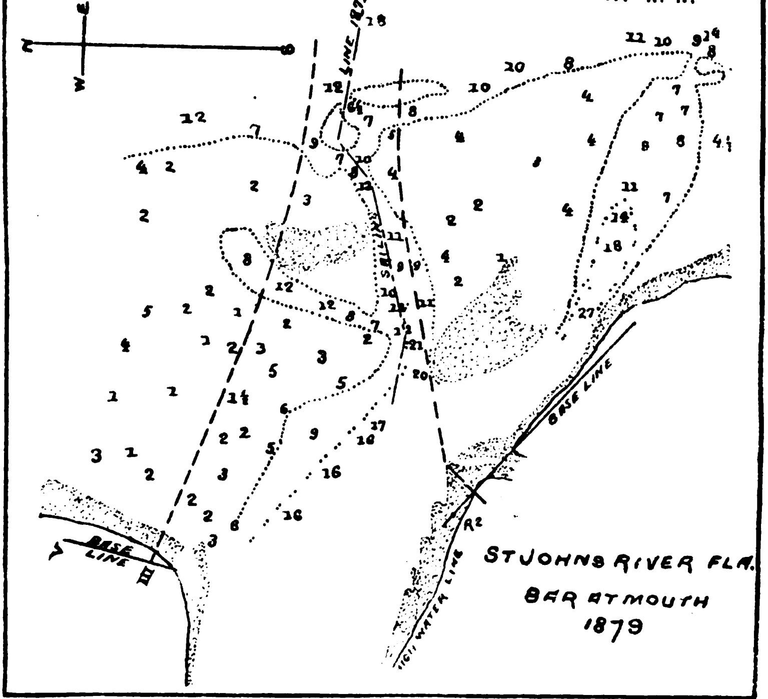
W. M. Black

LIEUT. OF ENGINEERS.



ST. JOHNS RIVER FLA.
BAR AT MOUTH
1883

NOTE
CURVES MARKED THUS
6 Ft. ....
12 Ft. .. ..
18 Ft. ... ...



ST JOHNS RIVER FLA.
BAR AT MOUTH
1879

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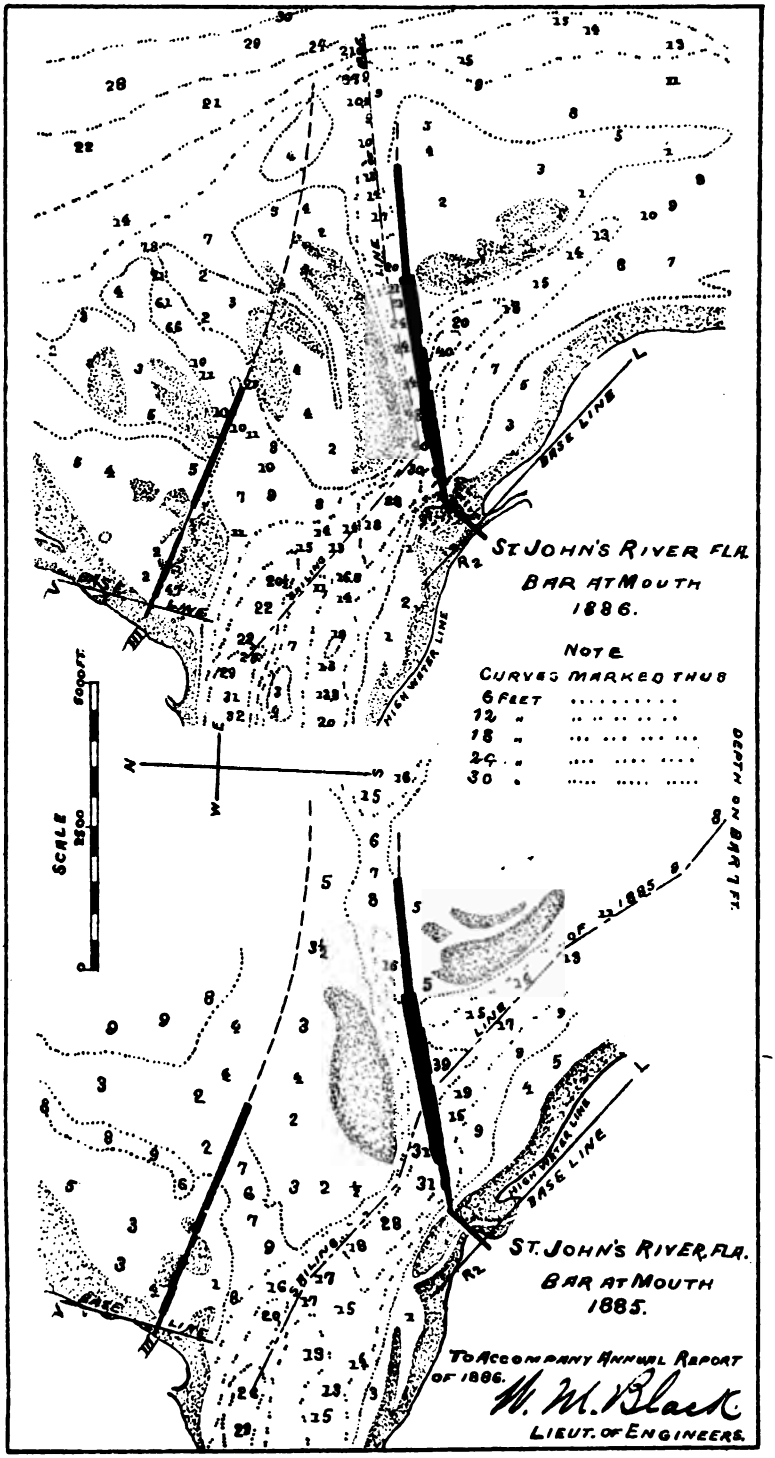
THE AMERICAN GRAPHIC CO. N.Y.



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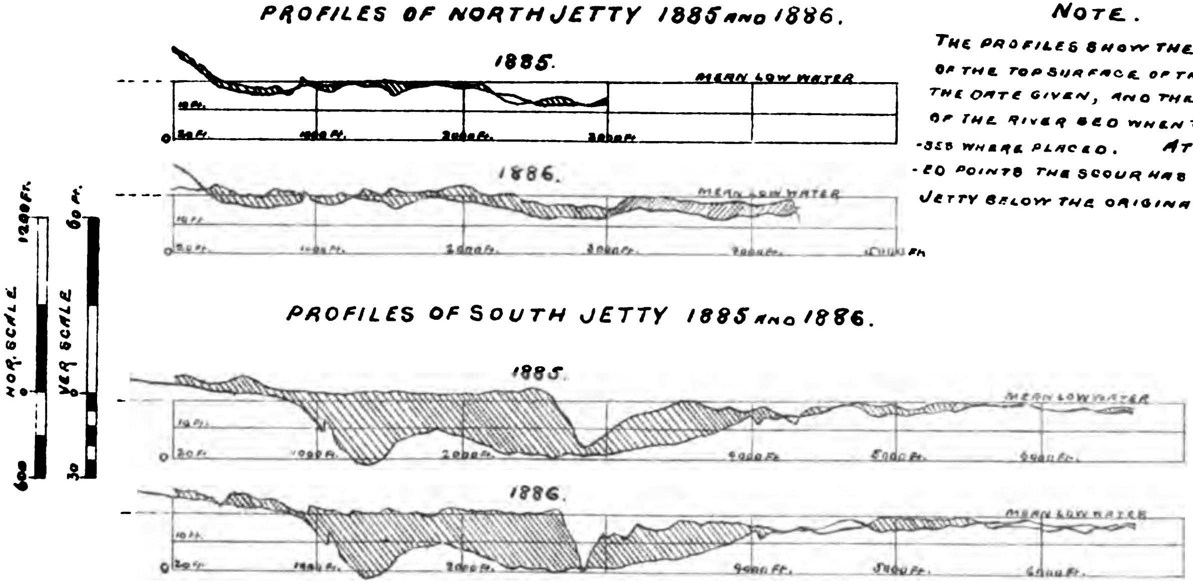
ST. JOHNS RIVER, FLA.

BAR AT MOUTH



NOTE.

THE PROFILES SHOW THE POSITION OF THE TOP SURFACE OF THE JETTY AT THE DATE GIVEN, AND THE POSITION OF THE RIVER BED WHEN THE MATTRESSES WHERE PLACED. AT THE UNSHADED POINTS THE SCOUR HAS SUNK THE JETTY BELOW THE ORIGINAL RIVER BED.

TO ACCOMPANY ANNUAL REPORT OF 1886.

W. M. Black

LIEUT. OF ENGINEERS.

THE AMERICAN GRAPHIC CO., N.Y.

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channel. This consideration would limit the use of the wood-hearting to places where the present mean low-water depth exceeds 11 feet. At all other points it would seem best to use nothing but stone above the mattress foundation. At present the jetties are sanded up to their full height as far as the shore 6-foot curves.

In the north jetty both ends have been cut out by storms. No other settlement is observable.

The jetty channel has been used by vessels since March, 1886. Its depth has varied from time to time, the jetties not being far enough advanced to sufficiently direct the currents. On June 30 there was across the bar a channel 400 feet wide at its narrowest point, 8 feet deep at mean low water, and with a mid-channel depth of 8.8 feet.

Should there be funds available, it is proposed to extend and raise the north jetty, to move its shore end to high-water mark, properly protecting it from future storm action, and as soon as safe to close the sailing gap in the south jetty.

SHOALS BETWEEN JACKSONVILLE AND THE BAR.

The latest charts show four points where there is not a continuous channel with a least mean low-water depth of 15 feet, viz, at Dame's Point, below the mouth of San Carlos Creek, opposite Saint John's Bluff, and below Marsh Island. I would recommend that either a portion of the general appropriation for the improvement of the Saint John's River be made available for an examination of these points for the purpose of preparing an estimate and project for their improvement, or that a special appropriation be made for the improvement of the lower Saint John's River. The estimated cost of this examination is $1,500.

NECESSITY FOR AN EARLY APPROPRIATION.

It would seem unnecessary again to invite attention to the yearly increase of the cost of the completed work caused by the many interruptions and delays in its construction. In addition to the ordinary deterioration of all unfinished work, jetties built on shifting sand are subject to conditions which in the interests of economy demand most urgently prompt action. The scour of the partially directed currents across the lines of the jetties deepens the water through which they must be built, and thus directly increases their cost. The final sanding up is prevented and their permanency endangered. As an instance, in the north jetty extension the material now required is fully twice what would have been needed could the jetty have been built one year ago. These conditions become more marked as the jetties approach completion and as the forces they produce become more powerful. In addition to these engineering necessities are the calls from the commercial interests. For these I would respectfully invite attention to the statements in the appended letter from the secretary of the Jacksonville Board of Trade. I would earnestly repeat the recommendations of my predecessors that in the interests of economy an early appropriation be made for carrying on the work.

This improvement is located in the collection district of Saint John's. Jacksonville is the nearest port of entry. Nearest light-house is Saint John's River Light. Nearest fort is Fort Clinch. Amount of duties collected in fiscal year 1886, $2,398.28.

The following appropriations have been made for this work since the present project of improvement was adopted:

By act of Congress approved June 14, 1880	$125,000
By act of Congress approved March 3, 1881	100,000
By act of Congress passed August 2, 1882	150,000
By act of Congress approved July 5, 1884	150,000
Total	525,000

The total expenditures to June 30, 1886, including outstanding liabilities, were $523,065.72.

The following papers accompany this report:

1. Map of mouth of river. Scale $\frac{1}{5000}$.
2. 3. Comparative maps mouth of river 1879, 1882, 1885, 1886. Scale, $\frac{1}{15000}$.
4. Profiles of jetties, 1885, 1886.
5. 6. Commercial statistics.

Money statement.

July 1, 1885, amount available		$30,925 95
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$28,339 33	
July 1, 1886, outstanding liabilities	652 34	
		28,991 67
July 1, 1886, amount available		1,934 28
Amount appropriated by act approved August 5, 1886		150,000 00
Amount available for fiscal year ending June 30, 1887		151,934 28
Amount (estimated) required for completion of existing project		631,409 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		600,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, JACKSONVILLE, FLA.,
Collector's Office, July 17, 1886.

SIR: Inclosed please find information asked for in your letter of the 19th ultimo.

Very respectfully, your obedient servant,

JOSEPH E. LEE,
Deputy Collector.

W. M. BLACK,
First Lieutenant of Engineers.

Port of Jacksonville, Fla.

ARRIVED.

Class, tonnage, &c.	Coastwise.		Foreign.	
	June 30, 1884, to June 30, 1885.	June 30, 1885, to June 30, 1886.	June 30, 1884, to June 30, 1885.	June 30, 1885, to June 30, 1886.
Steamers	107	123	....	5
Sailing vessels	221	228	20	27
Total tonnage	114,919	119,280	1,978	[illegible]
Total of crews	4,338	8,057	137	[illegible]

CLEARED.

Class, tonnage, &c.	Coastwise.		Foreign.	
	June 30, 1884, to June 30, 1885.	June 30, 1885, to June 30, 1886.	June 30, 1884, to June 30, 1885.	June 30, 1885, to June 30, 1886.
Steamers	112	115	....	3
Sailing vessels	177	177	36	36
Total tonnage	100,037	109,721	5,808	6,323
Total of crews	4,091	4,407	245	349

Port of Jacksonville, Fla.—Continued.

Value of exports and imports and duties collected.	June 30, 1884, to June 30, 1885.	June 30, 1885, to June 30, 1886.
Value of exports	$54, 071 32	$42, 241 55
Value of imports	35, 376 54	72, 007 60
Duties collected	473 86	2, 398 28

LETTER OF THE JACKSONVILLE BOARD OF TRADE.

ROOMS OF THE JACKSONVILLE BOARD OF TRADE,
Jacksonville, Fla., July 14, 1886.

DEAR SIR: In response to your request to Col. J. J. Daniel, president of this board, which was referred to me, I have the honor to submit the accompanying statements, which have been carefully compiled by the statistical committee of the Board of Trade.

Hoping the information will be of value to you in your report, I have the honor to be, with high regards,

Yours, most respectfully,

JAMES M. FAIRLIE,
Secretary.

W. M. BLACK,
First Lieutenant of Engineers, U. S. A.

THE COMMERCIAL INTERESTS OF JACKSONVILLE, FLORIDA.

Saint John's Bar commerce for one year, from January 1, 1885, *to December* 31, 1885.

Vessels entered	466
Vessels cleared	374
Net tonnage of vessels arriving and departing (tons)	264, 004
Estimated value of vessels and cargoes	$34, 592, 312
Upon this amount shippers are required to pay increased insurance over that of the neighboring ports, caused by the risks in crossing the Saint John's Bar, from ⅓ to ⅔ per cent	225, 687
Together with increased freight charges from the same cause, 50 cents per ton	178, 772
The loss by delays, caused by the bad condition of the bar, 678 days	24, 675
Damage to vessels and cargoes on the bar	6, 250
Estimated loss to commerce by not having a good harbor of refuge at the mouth of the Saint John's River, made by underwriters' agent	100, 000
Gross burden on the commerce of the city of Jacksonville during the year 1885, which the completion of the improvements on the bar would have saved	535, 384

LUMBER SHIPMENTS.

The total number of feet of sawed lumber shipped from the port of Saint John's (Jacksonville) during the year 1885 was	40, 271, 150

Saint John's Bar commerce for five years, from January 1, 1880, *to December* 31, 1884.

Vessels entered	1, 882
Vessels cleared	1, 897
Net tonnage of vessels arriving and departing	1, 250, 897
Estimated value of vessels and cargoes	$172, 405, 641

Upon this amount the increased insurance over that of other neighboring ports, caused by risks of this bar, is from ¼ to ¾ per cent	1,137,240
The increased freight charges from the same cause average 50 cents per ton	574,294
The loss by delays, caused by the bad condition of the bar, 4,500 days	165,000
The loss of vessels and merchandise on the bar	90,000
Loss to commerce by not having a good harbor of refuge in this river, estimated by underwriters' agent at $100,000 per annum	500,000
Total burden on the commerce of Jacksonville in the last five years, which the completion of the improvements on the bar would save	2,466,534

LUMBER SHIPMENTS.

Feet of sawed lumber shipped in five years, from January 1, 1880, to December 31, 1884 258,794,152

Value of exports and imports and duties collected.

Year.	Value of exports.	Value of imports.	Duties collected.
1878	$74,085 00	$1,363 27	$181 52
1879	92,890 00	15,819 26	771 21
1880	94,680 00	888 40	98 91
1881	62,205 00	2,380 08	230 [illegible]
1882	68,583 00	12,542 51	4,701 [illegible]
1883	45,120 86	4,038 28	490 1
1884	44,368 52	29,196 77	724 [illegible]

Lumber shipped from the port of Jacksonville, Fla., for the year ending December 31, 1885, to domestic ports was .... feet	36,533,000
To foreign ports .... do	2,115,000
Besides this there was shipped to domestic ports red cedar lumber .... do	30,000
Red cedar logs .... do	1,740
Laths	10,000

One car load of pine-knots.

COMMERCIAL INTERESTS OF JACKSONVILLE.

The population of Jacksonville is steadily increasing. The city and suburban population in 1878 was 12,170, in 1880 was 13,470, in 1882 was 15,904, in 1884 was 18,740, in 1886 was 21,589.

The total number of buildings in the city of Jacksonville are 4,281. There are 54 manufacturing establishments, 471 mercantile buildings, 20 hotels, 100 private boarding houses, 11 livery stables, 5 machine-shops, 45 warehouses for storing goods, 2 foundries, 4 boiler works, 6 freight depots, 4 brick-yards, 5 ship-yards, 3 marine railways, 7 large saw-mills and 8 shingle and wood mills, 1 opera-house, 17 public halls, 39 churches, 14 school-houses, 21 cigar factories, 3 ice factories, 3 wagon and carriage establishments. There are 102 grocers and provision merchants, with 342 employés, whose combined business aggregated, during 1885, $3,056,422.10. Eight grain, hay, and flour merchants, with 80 employés, handled merchandise valued at $1,354,000.

Twenty-one produce and commission merchants, with 87 employés, sold goods during last year to the value of $606,000.

The other branches of business are represented as follows:

18 fruit and confectionery stores, 43 employés	$60,800
6 hardware and building-material stores, 125 employés	930,000
18 dry-goods houses, 209 employés	1,845,500
5 boot and shoe stores, 39 employés	240,000
7 furniture stores, 61 employés	214,000
2 musical instruments, 17 employés	60,000
8 lumber mills and naval stores, 750 employés	1,000,000
3 book stores, 19 employés	117,414
16 drug stores, 57 employés	159,448
3 earthenware stores, 20 employés	90,000
9 jewelry and curiosity stores, 66 employés	171,000

Twenty-one cigar factories, 450 employés, consumed, in 1885, 110,400 pounds tobacco; paid the internal-revenue collector $13,152 in stamp taxes, and made 5,060,025 cigars, valued at $200,000.

Four brick-yards, 35 employés, produced 10,500,000 brick, valued at $94,500.

Three wagon and carriage establishments, with 26 employés, $40,000.

This is only a partial record of the business done in Jacksonville. When business of the railroads, the shipping companies, the machine and boiler shops, the ship building and repairing, iron working and castings, harness, ice factories and dealers, stone and terra-cotta works, fertilizers, palmetto goods, brushes, &c., is considered the sum of $20,000,000 will be a small estimate of the actual business done in the city.

REAL ESTATE.

The assessed value of real estate has increased from 100 to 300 per cent. in the last thirteen years. In 1873 some of the best corner lots in the city were offered for sale at from $500 to $1,000 per lot, of 105 feet front and running back to the river. These same lots are now valued at and sold for $1,000 per foot front; while the property in other parts of the city and in the suburbs has increased in a proportionate ratio.

RAILROAD BUSINESS.

There are now ready nearly 2,000 miles of railway in operation in the State of Florida, every mile of which has direct connection with one or the other of the six railways which center at Jacksonville or with the great tributary, the Saint John's River.

Freight handled during 1885:

Inward freights	tons..	214,029
Outward freights	do...	36,274
Total		250,303
Orange shipments by rail	boxes..	403,157
Orange shipments by steamers	do...	123,481
Total		526,638
Vegetable shipments	crates..	200,000
Strawberry shipments	do...	200,000
Shipments of fish and oysters valued at		$65,000

The entire crop of oranges in Florida during 1885 was nearly 1,000,000 boxes. It will thus be seen from the above statement that fully one-half the Florida freight business is at present tributary to Jacksonville as the port of the Saint John's River.

The amount paid by the Jacksonville merchants during 1885 for eastern freights exclusively was $241,079.77.

Messrs. C. H. Mallory & Co., of New York, agents for the Mallory line of Texas and Florida steamships, in a letter to the Jacksonville Board of Trade under date of November 16, 1885, states that if there were 16 feet of water on the Saint John's Bar they would put on a line of steamers between New York and Jacksonville "that would be equal to any flying the flag of the United States."

If, therefore, Jacksonville handles more than half the freight coming into and going from the State with the present want of transportation and shipping facilities over the bar, it is safe to say that with the bar deepened and from two to six steamers per week entering the port from coastwise ports, besides the impetus that would at once be given the export and import business with the West Indies and other points, Jacksonville would undoubtedly do much more of the freight business than all the other ports in Florida put together.

N 2.

IMPROVEMENT OF THE UPPER SAINT JOHN'S RIVER, FLORIDA.

By the river and harbor act approved July 5, 1884, the sum of $5,000 was appropriated for improving the Upper Saint John's River, Florida. This is the first appropriation ever made by Congress for this work.

The part of the Saint John's River referred to in the act is presumed to be that portion extending from Lake Monroe to the head of Lake George, a distance by river of about 45 miles. An examination of this section was made in the early part of the year 1879, report of which, dated July 16, 1879, with a project of improvement, is printed as Appendix I 9, Annual Report of the Chief of Engineers for 1879. It was stated in that report that the stream, although very crooked, is of ample depth for any class of vessels adapted to the navigation of the Upper Saint John's River, and that the only gain to be secured by cut-offs is strictly in distance. It was suggested to confine the work of improvement to cutting off the four most prominent bends, located as follows:

(1) A bend three-fourths of a mile above Old Town, 25 miles below Lake Monroe.

(2) Two bends about 2 miles below Manuel's Landing, 7½ miles below Lake Monroe.

(3) A bend at Manuel's Landing, 5½ miles below Lake Monroe. The results of a later examination of the same section of the river, made in conformity to a provision in the river and harbor act passed August 2, 1882, did not differ from the conclusions previously reached.

Pursuant to instructions from the Department, another report was submitted October 5, 1883, with revised plans and estimates.

The width of the river at the bends named varies from 130 to 150 feet, and in the reaches connecting them from 150 to 200 feet. The banks and adjoining ground average 4 feet above water-surface at low-river stage. The plan of improvement contemplates cut-offs 100 feet wide at the bottom, side slopes 1 on 1, and a low-river depth in the cuts of 6 feet. This depth was adopted as being the maximum low-river depth at the shoalest places between Little Lake George, 20 miles below the head of Lake George and Lake Monroe.

Two estimates were submitted, one for straight cut-offs and the other for curved cut-offs with quite easy curves so as to offer no obstruction to navigation. The work would principally consist of dredging, but a few light closure dams would have to be built and some grubbing done. The estimated cost of this improvement is $43,000 for straight cut-offs, and $38,800 for curved cut-offs. The latter system has been adopted.

The appropriation available being small, it was proposed to begin operations by opening the shortest cut, that at Old Town. Proposals for this work were invited, to be opened October 24, 1884. No bids were received.

Under these circumstances, with the approval of the Chief of Engineers, it was decided to await further appropriations before beginning the work.

This part of the river is passed over by steamboats about twelve times per day.

From the beginning of the fiscal year the work was under the charge of Capt. W. T. Rossell, Corps of Engineers, until he was relieved by me April 26, 1886, in accordance with Special Orders No. 96, paragraph 2, Headquarters of the Army, Adjutant-General's Office, Washington, April 16, 1886.

The balance available and the appropriation asked for are to be used in accordance with the approved project.

This work is located in the collection district of Saint John's. Jacksonville is the nearest port of entry. Nearest light-house is Dame's Point Light. Nearest fort is Fort Marion. Amount of duties collected in fiscal year, $2,398.28.

Money statement.

July 1, 1885, amount available	$4,979 21
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	4 05
July 1, 1886, amount available	4,975 16
Amount (estimated) required for completion of existing project	33,800 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	33,800 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

N 3.

IMPROVEMENT OF VOLUSIA BAR, FLORIDA.

Operations for improving Volusia Bar, Florida, have been carried on at intervals since December, 1880. Four appropriations have thus far been made by Congress for its improvement previous to the current fiscal year, aggregating $17,500.

Volusia Bar is located at the south end or head of Lake George, about 162 miles by river from the mouth of the Saint John's River, at the point where the waters of the river flow into the lake.

Twelve steamboats pass this point daily, having a total tonnage of about 5,130 tons.

An examination of Volusia Bar with a view to its improvement was made in March, 1879. A report thereon, dated July 16, 1879, with plan of improvement, is printed as Appendix I 9, Annual Report of the Chief of Engineers for 1879.

This was modified as reported in the Annual Reports of the Chief of Engineers for 1882 and 1883, Appendix J 11 and L 14, respectively.

PROJECT OF IMPROVEMENT.

This consists of the narrowing of the channel by two converging brush and stone jetties, starting from the shore and extending to the 6-foot curve in the lake, and with such width between the ends as will maintain a channel-depth of 6 feet at low water, where before improvement the depth was 3½ to 4½ feet. The channel is to be further defined and guarded by rows of fender-piles. Dredging is to be resorted to if necessary to obtain the required depth.

The estimated cost of the revised project is $25,000.

It is estimated that about 12,000 cubic yards of material should be removed by dredging.

OPERATIONS TO JUNE 30, 1885.

The west jetty, built on a straight line bearing north 25 degrees west, has reached a length of 2,206 feet from shore. For the greater part it is formed of a single course of pole and brush mattresses from 6 to 12 feet wide, loaded with broken stone. A second course of 6-foot mattresses covers 159 linear feet of the outer portion of the jetty.

The shore-end of the east jetty is about 2,400 feet east of the west etty. It is built on lines by which it gradually converges toward the atter work in approaching the bar. Its aggregate length is at present

3,459 feet. From the shore it extends 1,836 linear feet on a range bearing north 76 degrees west; the next length of 1,100 feet bears north 63 degrees west, and the remainder, which is located upon the bar, runs about parallel to the opposite part of the west jetty, and 240 feet from it. It generally consists of a single course of mattresses from 6 to 12 feet wide, covered with riprap-stone, except for 247 feet length at the bar, where a second course was put on.

One hundred and fifty fender-piles were driven on the bar, nearly all in clusters of three and four, in two rows 75 feet apart. Each row extends over a length exceeding 800 feet, and runs about parallel to the west jetty. The row nearest to that work is 100 feet from it. At the beginning of the fiscal year, July 1, 1884, all of these piles had been broken or knocked down. In this condition they formed a serious obstruction to navigation.

In 1885 the broken piles were removed. New piles were driven in clusters, and securely fastened with chains. The width between rows was increased to 100 feet, and the piles were increased in size. Stone was placed on low spots on east jetty.

OPERATIONS DURING THE PAST FISCAL YEAR.

The appropriation having been nearly exhausted, no operations were carried on during the year.

From the commencement of the fiscal year, the work was under the charge of Capt. W. T. Rossell, Corps of Engineers, until he was relieved by me, April 26, 1886, in accordance with Special Order No. 89, paragraph 2, Headquarters of the Army, Adjutant-General's Office, Washington, April 16, 1886.

THE EFFECTS OF THE WORK AND CONDITION GENERALLY.

Although settlement has taken place along both jetties, they are still in good condition and have sanded up along the whole length.

On June 30, 1886, 121 out of the 158 piles driven in 1885 were still standing. A uniform depth of 5 feet 8 inches existed throughout the channel.

Since the work of improvement was commenced, the following appropriations have been made:

By act of Congress approved June 14, 1880	$5,000
By act of Congress approved March 3, 1881	5,500
By act of Congress passed August 2, 1882	5,000
By act of Congress approved July 5, 1884	2,000
Total	17,500

Of this amount the sum of $17,340.26 has been expended to June 30, 1886.

The balance available and the appropriation asked for are to be used in raising and extending the jetties, in keeping the fender-piles up, and in dredging if necessary.

This work is in the collection district of Saint John's; Jacksonville is the nearest port of entry. Nearest light-house is Dame's Point Light. Nearest fort is Fort Marion. Amount of revenue collected in 1886, $2,398.28.

Money statement.

July 1, 1885, amount available		$162 49
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$2 75	
July 1, 1886, outstanding liabilities	12 00	
		14 75
July 1, 1886, amount available		147 74
Amount appropriated by act approved August 5, 1886		7,500 00
Amount available for fiscal year ending June 30, 1887		7,647 74

COMMERCIAL STATISTICS.

[General offices De Bary Baya Merchants' Line, Saint John's River steamers.]

JACKSONVILLE, FLA., *June* 24, 1886.

DEAR SIR: In reply to yours of 19th instant relative to number of vessels passing through the Upper Saint John's, amount of tonnage, &c., I beg to send you the following, the same being as nearly as I can come to the facts:

Number of steamers from Jacksonville	4
Number of steamers from Palatka	2
Total	6

This would amount to 12 boats passing daily, as the trips were made both up and down.

The amount of tonnage is about 5,130 tons.

Hoping that the above may prove of service to you,

I am, respectfully, yours,

H. T. BAYA,
General Manager De Bary Baya Merchants' Line.

Lieut. W. M. BLACK,
United States Engineers.

N 4.

IMPROVEMENT OF TAMPA BAY, FLORIDA.

Tampa Bay is a large indentation in the Gulf coast of Florida, with an average width of from 6 to 7 miles, and a length including Hillsborough and Old Tampa Bay, into which its inner end is divided, of 35 miles. Across the bar and up to the point of division, a distance of 25 miles, the channel has a depth of from 20 to 38 feet.

Old Tampa Bay, the northwestern division, is about 10 miles long, with an average width of 5½ miles. Near its mouth there is a channel depth of over 20 feet of water. A depth of 10 to 12 feet extends to its head. Hillsborough Bay has an average width of 5 miles, with depth varying from 16 feet at the mouth to 8 feet near head. Flats with low-water depth from 1 foot to 5 feet, varying in width from one-fourth to 1 mile, surround the entire body of water.

Its principal tributary is the Manatee River. The principal town is Tampa, lying at the mouth of the Hillsborough River, at the head of Hillsborough Bay, but separated from the deep water of the bay by a broad flat, through which runs a narrow channel formed by the waters of Hillsborough River. This, before improvement, permitted vessels drawing 8 feet of water to reach Tampa only by taking advantage of high tides.

Tampa is the terminus of the South Florida Railroad, which there forms connection with the steamship lines for Key West, Havana, and New Orleans. The South Florida Railroad gives by its connections at present a through line to the North, East, and West by the Saint John's River from Sanford, the eastern terminus. Other railroads are projected to Tampa.

An examination of Tampa Bay, with a view to its improvement, was made in 1879. A report thereon, dated August 25, 1879, with a plan of improvement, is printed as Appendix J 18 to the Report of the Chief of Engineers for 1879.

PROJECT OF IMPROVEMENT.

The proposed improvement consists in deepening and widening the channel from Tampa to the bay, by dredging and rock excavation, so as to give a clear depth of 9 feet at mean low water, and a width in the river of 200 feet and in the bay of 150 feet, a total distance of 5¾ miles.

OPERATIONS TO JUNE 30, 1885.

The following appropriations have been made by Congress:

By act approved June 14, 1880	$10,000
By act approved March 3, 1881	10,000
By act passed August 2, 1882	20,000
By act approved July 5, 1884	20,000
Total	60,000

The work has been done by contract.

On June 30, 1885, a channel generally 60 feet wide, 9 feet deep at mean low water, 8,215 feet long through the bay, and 150 wide, with same depth, through the ledge at the mouth of the Hillsborough River, was reported to have been dredged. This, however, was obstructed by shoals at various points, notably at two places below Spanish Town Point, and for about 1,000 feet above Spanish Town Creek, where the depth was only 7½ feet. The channel had also narrowed at many places.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1886.

Dredging was continued by Mr. James E. Slaughter under the contract approved by the Chief of Engineers March 12, 1885, as reported in the last Annual Report. On August 14 work was suspended for the season.

The work done under this contract resulted in a channel from deep water of Hillsborough River towards the bay, 4,793 feet in length and varying in width from 45 to 150 feet, with an average depth of 9 feet at mean low water; 28,093.73 cubic yards of mud and 1,200 cubic yards of stone were removed.

An examination made in May, 1886, showed the center line of the channel but little changed. The sides of the cut had been crumbled in by the wash of boats passing, and cross-currents had shoaled the cut slightly at one place.

To complete the channel according to the original project 180,000 cubic yards of material must be removed, at an estimated cost of $73,000.

151,455 cubic yards mud, at 35 cents	$53,009 25
2,000 cubic yards rock, at $4	8,000 00
Engineering expenses and contingencies	12,201 85
Total	73,211 10

HEAD OF TAMPA BAY FLA.

(TAKEN FROM COAST SURVEY CHART No 77)

SHOWING DREDGED CHANNEL AND PROPOSED TIDAL BASIN

STATUTE MILES

NOTE

DREDGED CHANNEL MARKED THUS ———

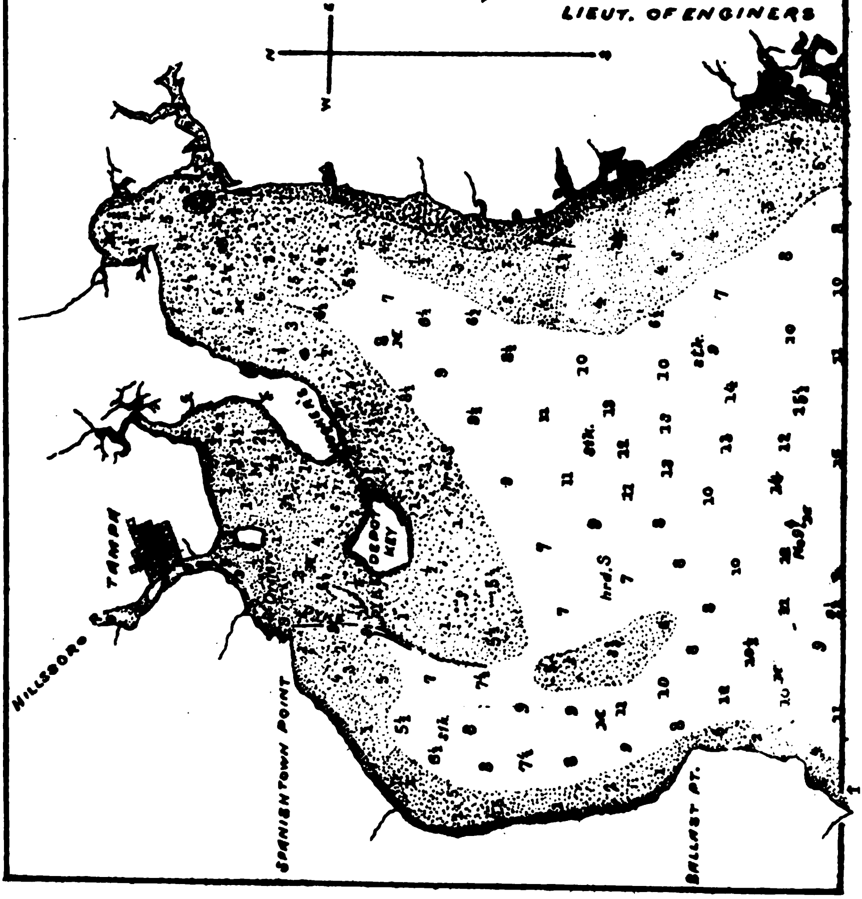
DYKE AROUND TIDAL BASIN " " - - - -

SOUNDINGS SHOW DEPTH IN FEET BELOW MEAN LOW WATER

TO ACCOMPANY ANNUAL REPORT FOR 1886

W. M. Black

LIEUT. OF ENGINEERS



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THE AMERICAN GRAPHIC CO. N.Y.

This increase over the original estimate is caused by the constant filling of the dredged channel by action of the tides.

The permanency of the dredged channel can be insured by the formation of a tidal basin to be filled and emptied through it. This can be done by building a dike, with top at level of mean high water, from Hooker's Point to Depot Key and thence west to the channel line, there joining a dike starting from the oyster-bed northeast of Spanish Town Point and running parallel to the channel as far as the 9-foot curve. In all, including the proper protection of Spanish Town Point, about 4,500 yards of dike would be required, of an average height of 3 feet. The tidal basin thus formed would cover an area of 39,647,000 square feet, with a tidal prism of 652,476,343 gallons. The estimated cost of this, if made of stone with mattress foundation, is $76,000.

13,705.5 cubic yards stone, at $3	$41,116 50
31,390.0 square yards mattress, at 70 cents	21,973 00
Engineering expenses and contingencies	12,317 90
Total	75,707 40

As the depths are generally slight, a creosoted-wood dike would probably be strong enough and sufficiently permanent.

The estimated cost of this is $50,000.

The balance available and the appropriation asked for is to be expended in accordance with the approved project.

Tampa Bay is in the collection district of Key West, which is the nearest port of entry. Nearest light-house, Egmont Key Light. Nearest fort is Fort Jefferson, Florida.

Money statement.

July 1, 1885, amount available	$12,198 50
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	11,368 04
July 1, 1886, amount available	830 46
Amount appropriated by act approved August 5, 1886	10,000 00
Amount available for fiscal year ending June 30, 1887	10,830 46
Amount (estimated) required for completion of existing project	63,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, TAMPA, FLA.,
Deputy Collector's Office, July 15, 1886.

SIR: Herewith inclosed please find statement of number of passengers, number of pieces of baggage, and amount of duties collected from small articles in said baggage.

Also paper headed "Commercial statistics of port of Tampa, Fla.," showing number of vessels arriving coastwise, with total tonnage, as well as number of foreign vessels arriving, *via* of Key West, at this port, with total tonnage of same.

Tampa is simply a port of delivery; hence all vessels coming from foreign ports must first enter at Key West, the port of entry, and proceed to this port under permit; hence no report on duties on imports or exports.

Very respectfully,

T. K. SPENCER,
Deputy Collector.

Lieut. W. M. BLACK,
Corps of Engineers.

Port of Tampa, Fla.

From October 31, 1885, to June 30, 1886.	Steamers.	Sailing vessels.	Total tonnage.
Coastwise	100	16	562,494
Foreign, by way of Key West	66	....	144,[illegible]

Tabulated statement of arrivals of passenger steamers, passengers and baggage, and duties collected thereon, for port of Tampa, Fla.

Period.	Total number of trips. Lines.		Total number of passengers carried.	Total number of pieces of baggage.	Duties collected on baggage.
	Plant.	Morgan.			
From November 28, 1884, to May 1, 1885	12	11	805	545	$228 76
From October 31, 1885, to June 30, 1886	40	26	1,142	2,279	2,181 [illegible]

N 5.

IMPROVEMENT OF APALACHICOLA BAY, FLORIDA.

Operations for the improvement of this bay were carried on during the past fiscal year in accordance with the project submitted to the Chief of Engineers, and published in the Annual Report for 1879, pages 823 and 824.

A bar existed at the mouth of the river, extending from half a mile below the town of Apalachicola, Fla., to the lower anchorage. The minimum depth of water over this bar was 3½ feet.

The plan proposed and adopted was the deepening of the channel to 11 feet, with a width of 100 feet.

The work was to be done under contract, by dredging, at an estimated cost of $100,000.

The following appropriations have been made:

By act approved June 14, 1880	$10,000
By act approved March 3, 1881	10,000
By act passed August 2, 1882	25,000
By act approved July 5, 1884	10,000
Total	55,000

OPERATIONS PRIOR TO JUNE 30, 1885.

Work was done under four contracts, and resulted in a channel-way 1,500 feet long, 100 feet wide, with a minimum depth of 9 feet at mean low water, and a continuation 4,178 feet long, 60 feet wide, and 9.5 feet deep, costing $54,284.37.

The material removed was in many places apparently of recent deposit.

Complaints have been made several times that sawdust from the saw-mills was finding its way into the channel, and the character of some of the dredged materials would go to prove the truth of this.

As stated in previous reports, there was but little chance of the dredged channel maintaining itself unless entirely opened. The appropriations heretofore made have not permitted this to be done, and on each occasion part of the old work had to be done over. On this account the original estimate will have to be increased by $23,000.

To complete the project 177,000 cubic yards of material remain to be dredged, at an estimated cost of $68,000.

OPERATIONS DURING THE PAST FISCAL YEAR.

No work was done after the completion of the contract in April, 1885, on account of an insufficient supply of money.

Recent reports from pilots crossing the bar show only 6½ feet of water in the dredged channel.

From the commencement of the fiscal year the work was under the charge of Capt. W. T. Rossell, Corps of Engineers, United States Army, until he was relieved by me, April 26, 1886, in accordance with paragraph 2, Special Orders No. 89, Headquarters of the Army, Adjutant-General's Office, Washington, April 16, 1886.

As stated in the Coast Survey charts of this bay, "the effects of the winds are often greater than the real tides, and the time and height of the apparent tides are greatly dependent on them." The prevailing gales are from the east, and, due to their influence, the natural channel, which at the mouth has a southeasterly direction, is bent sharply to S. ¾ E. through an angle of 36 degrees, and then is nearly straight for a distance of about 8,000 feet, when it spreads and is lost on the flats, which have a general depth of about 4½ to 5 feet. The area of cross-section of the natural channel at the mouth of the river is 13,143 square feet; opposite the tow-head it is 13,200 square feet. Beyond this point it rapidly diminishes in depth. If from this point to the 9-foot curve the dredged channel could be protected on the east side by a dike, it would probably be permanent. If not, the permanency could be insured by connecting the dike with the shore by a jetty, with an additional jetty on the west side, if necessary. The dike alone would probably be sufficient, however. Its estimated cost, if of stone on a mattress foundation, would be $110,823, or if of re-enforced creosoted sheet-piling, $83,823.

The balance available and the appropriation asked for is to be used in extending, widening, and deepening the cut by dredging, under the project.

Apalachicola Bay is in the collection district of Apalachicola, which is the nearest port of entry. Nearest light-house, Cape Saint George Light. Nearest fort, defenses of Pensacola, Fla. Amount of revenue collected during fiscal year, $1,320.

Money statement.

July 1, 1885, amount available	$715 63
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	18 90
July 1, 1886, amount available	696 73
Amount appropriated by act approved August 5, 1886	12,000 00
Amount available for fiscal year ending June 30, 1887	12,696 73
Amount (estimated) required for completion of existing project	56,696 73
Amount that can be profitably expended in fiscal year ending June 30, 1888	40,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, APALACHICOLA, FLA.,
Collector's Office, July 7, 1886.

Port of Apalachicola, Fla.

ARRIVED.

Class, &c.	Coastwise.		Foreign.	
	June 30, 1884, to June 30, 1885.	June 30, 1885, to June 30, 1886.	June 30, 1884, to June 30, 1885.	June 30, 1885, to June 30, 1886.
Sailing vessels	28	27	68	[illegible]
Total tonnage	8,896	7,911	34,936	22,[illegible]

CLEARED.

Sailing vessels	32	35	66	[illegible]
Total tonnage	10,598	11,134	36,335	20,[illegible]

Value of exports and imports and duties collected.	June 30, 1884, to June 30, 1885.	June 30, 1885, to June 30, 1886.
Value of exports	$266,000 00	$164,000 [illegible]
Value of imports	1,512 00	2,882 [illegible]
Duties collected	985 00	1,320 [illegible]

ADDITIONAL INFORMATION AND STATISTICS OF WHICH NO OFFICIAL RECORD IS KEPT IN CUSTOM-HOUSE.

Number of steamers on river 6, of which one arrives at Apalachicola about every day.

Number of small coaling vessels, from 20 to 300 tons, that enter this port for cargo, of which no official record is kept (for 1886), 150.

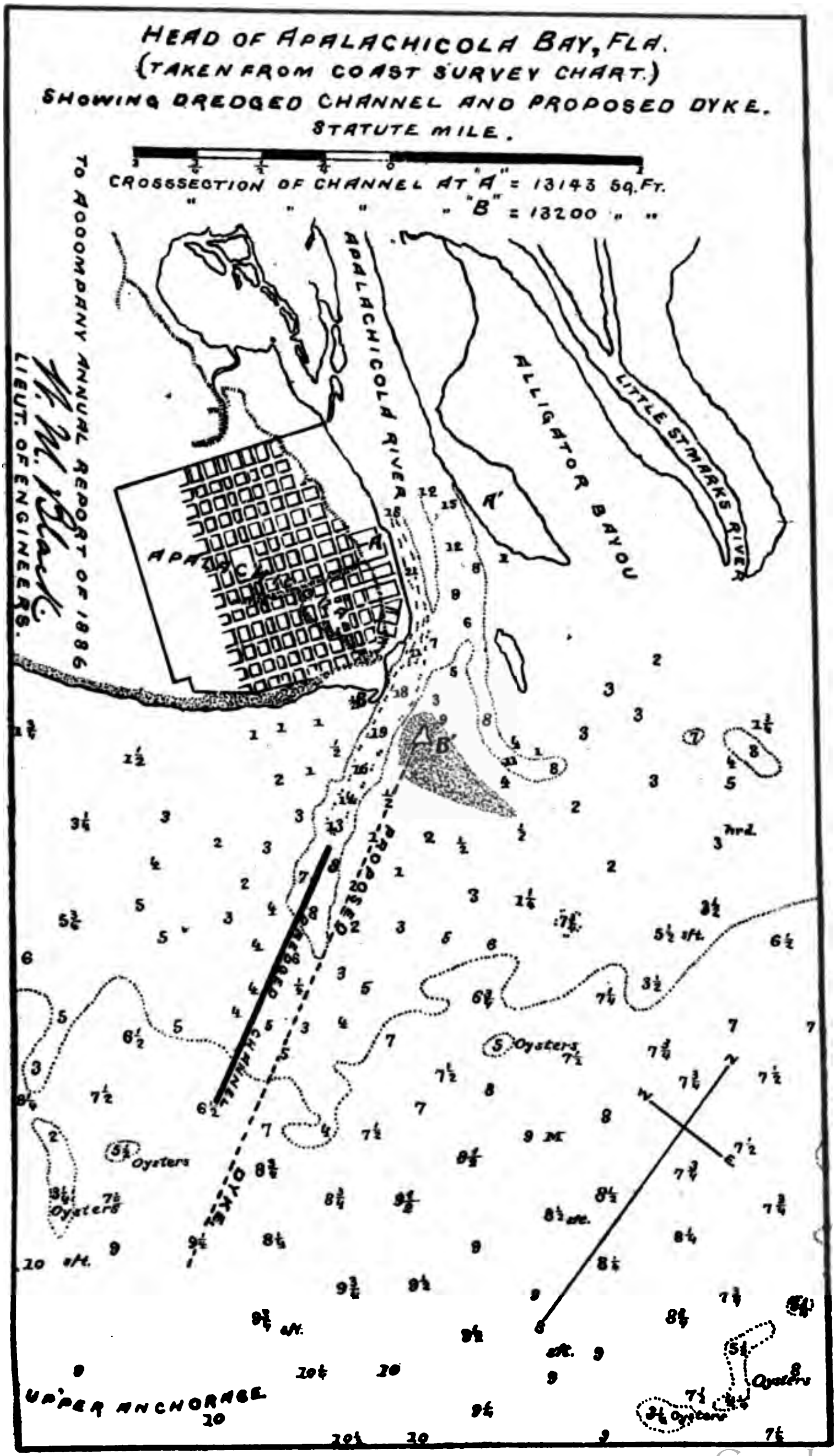
Merchandise shipped coastwise for 1886, $1,500,000.

Merchandise received for Apalachicola and up the river, $1,000,000.

J. E. GRADY,
Collector of Customs.

I am indebted to Mr. Columbus Drew, of Jacksonville, Fla., for the following statement of the number of vessels entered and cleared coastwise at and from the district and port of Apalachicola, Fla.:

Year.	Entrance.		Clearance.	
	Number of vessels.	Tonnage.	Number of vessels.	Tonnage.
1875	29	1,139	23	[illegible]
1876	18	424	18	[illegible]
1877	22	351	17	[illegible]
1878	12	1,150	16	1,911
1879	12	1,808	26	3,[illegible]
1880	37	9,568	41	10,[illegible]
1881	51	10,426	63	15,[illegible]
1882	50	12,647	62	18,[illegible]
1883	34	9,699	37	12,[illegible]
1884	29	9,579	34	10,[illegible]
Total	294	56,786	337	74,[illegible]


HEAD OF APALACHICOLA BAY, FLA.
(TAKEN FROM COAST SURVEY CHART.)
SHOWING DREDGED CHANNEL AND PROPOSED DYKE.

CROSSSECTION OF CHANNEL AT "A" = 13143 Sq. Ft.
" " " " "B" = 13200 " "

TO ACCOMPANY ANNUAL REPORT OF 1886

W. M. Black
LIEUT. OF ENGINEERS.

THE AMERICAN GRAPHIC CO. N.Y.

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N 6.

IMPROVEMENT OF THE SUWANEE RIVER, FLORIDA.

Operations for the improvement of this river have been carried on since November, 1881, under appropriations made in 1880, 1881, 1882, and 1884, aggregating $18,000.

The Suwanee River rises in the southern part of Georgia, near the Okefinokee Swamp, and, flowing in a general southerly direction, empties into the Gulf of Mexico, a few miles north of Cedar Keys. The portion surveyed with a view to its improvement extends from Ellaville to its mouth. The country adjacent is well wooded, and the chief trade is in pine, cypress, and cedar timber. Cotton, sirup, and the minor farm products are also sent to market at Cedar Keys.

An examination of this river, with a view to its improvement, was made in 1879. A report thereon, dated August 26, 1879, with a plan of improvement, is printed as Appendix J 16, Report of the Chief of Engineers for 1879.

PROJECT OF IMPROVEMENT.

The proposed improvement consists in deepening the bar at the passes by dredging, the removal of snags and overhanging trees along the river, and deepening and improving the channel at various places by the removal of rocks, snags, and construction of dams, so as to strengthen, widen, and deepen the channel. The depth to be obtained is 5 feet through the bars at the passes for a width of 150 feet, and up the river as far as Roland's Bluff, a distance of 74 miles. From there up to Ellaville, a distance of 50 miles, the depth is to be 4 feet and the width 60 feet.

OPERATIONS PRIOR TO JUNE 30, 1885.

The following appropriations have been made:

By act approved June 14, 1880	$5,000
By act approved March 3, 1881	3,000
By act passed August 2, 1882	5,000
By act approved July 5, 1884	5,000
Total	18,000

The work has been done by contract. Twenty-nine thousand six hundred and forty-nine cubic yards of material have been removed. All of the work has been in the channel over the bar at the East Pass. This resulted in securing a cut 2,400 feet long, 65 feet wide, and 6½ feet deep at mean low water, with an extension 829 feet long, 60 feet wide, and 5 feet deep.

Upon examination of the channel later, it was found that favorable winds had caused it to scour out, so that at the end of the fiscal year 1885 the channel was 4,429 feet long, 60 feet wide, and 5 feet deep at the shoalest point.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The work was continued under the contract with Mr. S. M. Kimball, approved by the Chief of Engineers, United States Army, January 17, 1885, and was finished July 14, 1885, by the near exhaustion of the appropriation. Four thousand five hundred and eighty-two cubic yards of material were removed, making a channel 1,406 feet long, 60 feet wide, and 5 feet deep at mean low water.

The distance from deep water in the Gulf through the East Pass to the deep water in the river is 15,600 feet. As reported above, a channel 5,835 feet long has been opened through this, with a mean low-water depth of 5 feet, and a width of 60 feet. There remains to be dredged here a distance of 9,765 feet where there is an average depth of 3½ feet.

No work has been done in the river above this point.

From the beginning of the fiscal year the work was under the charge of Capt. W. T. Rossell, Corps of Engineers, United States Army, until he was relieved by me, April 26, 1886, in accordance with paragraph 2, Special Orders No. 89, Headquarters of the Army, Adjutant-General's Office, Washington, April 16, 1886.

The balance on hand, and the appropriation asked for will be expended in carrying on the existing project.

Suwanee River is in the collection district of Cedar Keys, Fla., and Cedar Keys is the nearest port of entry. Nearest light-house is Cedar Keys Light. Nearest fort is Fort Marion, Florida.

No commercial statistics could be obtained.

Money statement.

July 1, 1885, amount available	$2,316 24
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,256 24
July 1, 1886, amount available	60 00
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,060 00
Amount (estimated) required for completion of existing project	32,158 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	32,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

N 7.

IMPROVEMENT OF HARBOR AT KEY WEST, FLORIDA.

Operations for the improvement of this harbor have been carried on since July 16, 1883, under appropriation made by Congress in 1882 of $25,000, the only appropriation made.

Key West is the most northwesterly of the Pine Islands, known as the Florida Keys, 60 miles southwest from Cape Sable, same distance from Tortugas, and 100 miles northeast from Havana. It is about 6 miles long, 2 broad, and from 12 to 15 feet above the sea level. It is of coral formation and sandy soil.

An examination of the harbor with a view to its improvement was made in December, 1881. A report thereon, dated February 16, 1882, with a plan of improvement is printed in Appendix K 25, of the Report of the Chief of Engineers, United States Army, for 1882.

PROJECT OF IMPROVEMENT.

The proposed improvement consisted in forming, by dredging, a channel 300 feet wide and 17 feet deep, at mean low water through the shoals of the northwest channel, a distance of about 5,000 feet.

OPERATIONS UP TO JUNE 30, 1885.

The work done was under contract. Dredging began July 28, 1883, and was continued until October 5, 1883, when the appropriation, $25,000, was exhausted. The work accomplished was the removal of 15,692 cubic yards of material, thereby securing one cut entirely through the bar, having a depth of 15 feet at mean low water and a width of 60 feet at bottom, and 65 feet at top.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

On July 1 the work was idle for lack of funds, and no appropriation has been made since.

From the beginning of the fiscal year the work was under the charge of Capt. W. T. Rossell, Corps of Engineers, until he was relieved by me, April 26, 1886, in accordance with paragraph 2, Special Orders No. 89, Headquarters of the Army, Adjutant-General's Office, Washington, April 16, 1886.

It was stated in the annual report for 1884 on this work that—

> Unofficial reports as to the filling up of the dredged channel confirm the opinion expressed in my last annual report, namely, that the improvement would not be permanent.

The following year personal inspections by Captain Rossell confirmed him in this opinion. His recommendation that an appropriation of $3,500 be made for an examination before more work is attempted is respectfully renewed, and the appropriation asked for will be applied to this purpose.

An improvement here would be of great benefit to all vessels plying between Key West and Gulf ports, the use of this channel saving a distance of about 100 miles to them.

The harbor at Key West is in the collection district of Key West, Fla., which is the nearest port of entry. Nearest light-house, Key West Light. Nearest fort is Fort Taylor, Florida.

Money statement.

Amount appropriated by act approved August 5, 1886	$2,500 00
Amount (estimated) required for completion of existing project	12,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	3,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Port of Key West, Fla.

By the courtesy of Mr. Columbus Drew, of Jacksonville, Fla., I am able to give the following statistics for this port, which includes the harbors of Key West, Charlotte Harbor, and Tampa, for the calendar year 1885.

Class, &c.	Arrived.		Cleared.	
	Coastwise.	Foreign.	Coastwise.	Foreign.
Steamers	85	2	87	[illegible]
Sailing vessels	82	55	85	[illegible]
Total tonnage	33,801	8,153	35,382	[illegible]

Value of exports and imports and duties collected.	Amount.
Value of exports	$207,[illegible]
Value of imports	664,[illegible]
Duties collected	49[illegible],[illegible]

N 8.

IMPROVEMENT OF PEASE CREEK, FLORIDA.

Operations for the improvement of this stream have been carried on since February 19, 1883, under appropriations made by Congress in 1881 and 1882, aggregating $11,000.

Pease Creek (Talakchopoko, Hatchee, or Peaseating Creek) rises in the northeastern part of township 30 south, range 26 east, and flows northwestward and westward to the middle of section 33, township 29 south, range 25 east, where it makes a junction with Saddle Creek, flowing southeastward from Lake Hancock. Thence its course is southwest to Hickory Bluff, where it empties into Charlotte Harbor, making about 15 miles westing and 66 miles southing. It is fed by numerous lakes in the central part of Polk County. The principal tributaries in the east are Little Charley, Tsala-apopka, Josh, and Prairie creeks, and on the west Saddle, Whitten, and Chilocohatchie creeks. Besides these streams, wide areas of swamp and hammock lands immediately bordering the river, and of the more elevated adjacent pine lands, are covered during the rainy season, in July and August, with shallow pools of water, which are discharged for the most part into Pease Creek. The stream therefore exhibits much variation in its stages of water, the range between extremes at Fort Meade being about 17 feet.

An examination of Pease Creek, with a view to its improvement, was made late in 1879. A report thereon, dated March 10, 1880, with a plan of improvement, is printed in Appendix K 17, Report of the Chief of Engineers for 1880.

PROJECT OF IMPROVEMENT.

The proposed improvement consists in rock excavation, removing snags, and clearing the banks of overhanging trees so as to enable boats drawing 2 feet of water to navigate during about half the year; minimum channel width to be 30 feet.

OPERATIONS UP TO JUNE 30, 1885.

The work has been done by a snag-boat built and equipped by the United States, and by hired labor.

Beginning at the mouth of the stream the work has been carried on for a distance of 64 miles.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

On July 1, 1885, the work was idle for lack of funds, and no appropriation has been made since.

From the commencement of the fiscal year the work was under the charge of Capt. W. T. Rossell, Corps of Engineers, until he was relieved by me April 26, 1886, in accordance with paragraph 2, Special Orders, No. 89, Headquarters of the Army, Adjutant-General's Office, Washington, April 16, 1886.

The small balance available for this work has been used in the care of public property.

It is estimated that $5,700 can be profitably expended during the fiscal year ending June 30, 1888.

The work is not yet sufficiently advanced to estimate whether there will be needed an additional sum to complete the present project.

It is not thought that the improvement will be permanent, and it is estimated that about $2,500 per annum will be necessary to clear the stream of drifts and washouts after each season of high water, in order to maintain the condition contemplated in the proposed project.

From the irregular and desultory character of the transportation, and from the fact that no reliable record is kept of the commerce of the river, which is entirely coastwise, the larger portion being transported overland to Tampa and Manatee, no authentic statement of the same can be given.

It is proposed to expend the appropriation asked for in continuing the removal of obstructions according to the project.

Pease Creek is in the collection district of Key West, and Key West is the nearest port of entry. Nearest light-house is on Cinnabel Island, and the nearest fort is Fort Taylor.

Money statement.

July 1, 1885, amount available		$546 82
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$32 75	
July 1, 1886, outstanding liabilities	30 00	
		62 75
July 1, 1886, amount available		484 07
Amount appropriated by act approved August 5, 1886		5,000 00
Amount available for fiscal year ending June 30, 1887		5,484 07

COMMERCIAL STATISTICS.

[Florida Southern Railway Company. Saint John's and Lake Eustis Railway Company. Florida Commercial Company.]

WARM SPRINGS, N. C., *July* 14, 1886.

DEAR SIR: Some weeks since your letter was received, requesting me to furnish you with such information, statistical and otherwise, as I might be in possession of in relation to business, present and prospective, of Charlotte Harbor, on the southwest coast of Florida. My reply has been delayed, owing to reasons beyond my control.

The recent completion of the Florida Southern road to Punta Gorda, on Charlotte Harbor, and the rapid influx of new settlers to that portion of the State, promises much commercial importance in the very early future to this locality, hitherto inaccessible except from the Gulf. Charlotte Harbor appears to be the most extreme southern harbor upon the mainland of Florida which is accessible to vessels of deep-water draught. The country bordering Peace River (Pease Creek) for 75 miles north from Punta Gorda is very fertile, and capable of very high development. The soil is generally very fertile and the tropical latitude of this portion of the State promises an immunity from the cold which has hitherto limited the productions of that portion of Florida which has been so rapidly settled during the past five years.

Since the completion of the Florida Southern road to Punta Gorda, steamboat communication has been opened up between this point and New Orleans, also between this point and the various settlements around Charlotte Harbor and on the Withlacoochee River. Before January 1, 1887, a steamship line running from Punta Gorda to Key West and Havana will have been established. At many points along the coast of Charlotte Harbor and on the Withlacoochee River, which is a tributary of this harbor, extensive plantations of cocoanut are being inaugurated; in short, all fruits of a purely tropical nature can be cultivated successfully in this latitude. The waters of Charlotte Harbor are swarming with fish, and large fisheries are now being established at Punta Gorda. Since the commencement of the construction of the railroad from Bartow to Punta Gorda seven large mills for the manufacture of yellow-pine lumber have been erected, with a probable capacity of 30,000,000 feet per annum, all of which will be shipped to domestic and foreign markets from Charlotte Harbor.

The shipment of cattle from points on this harbor to Havana and other Gulf markets has lately been recommenced. The cattlemen estimate that 100 schooner loads per annum is a fair approximation of the shipments which will be made during the next five years.

I regret my inability to give more accurate figures, but as the business of this locality is done through the custom-house at Key West, it has been impossible to obtain the accurate figures which you requested. The next twelve months will show a settlement of this portion of the State and a development of business unprecedented in Florida, and in another twelve months it will be possible to present in a more accurate manner the information which you have requested.

Yours truly,

S. CONANT,
General Manager.

Lieutenant BLACK,
First Lieutenant, U. S. Engineers.

N 9.

IMPROVEMENT OF THE HARBOR AT CEDAR KEYS, FLORIDA.

An improvement was made of this harbor in 1872–1881, as follows:

A cut 200 feet wide and 11¼ feet deep, down to the limestone, through the middle ground; another, 200 feet wide and 12 feet deep, through the outer bar, excepting at a point 80 feet from the line of black buoys, where the limestone is 11¼ feet under the surface, the remaining 120 feet on the east side of the cut being fully 12 feet deep.

The harbor of Cedar Keys lies on the Gulf side of the peninsula of Florida. It is the terminus of the Central Division Florida Railroad and Navigation Company. For years this was the only line of railroad between the Gulf and the Atlantic south of Pensacola, in Florida. The principal business done is in lumber, and it forms a distributing point to a large area to the north and south of it.

An examination with a view to its improvement was made in November, 1883. A report thereon, together with a plan of improvement, was printed as Appendix N 30 to the Report of the Chief of Engineers for 1884.

HARBOR AT CEDAR KEYS.
(TAKEN FROM COAST SURVEY CHART).
SHOWING POSITION OF DREDGED CHANNEL.

STATUTE MILES.

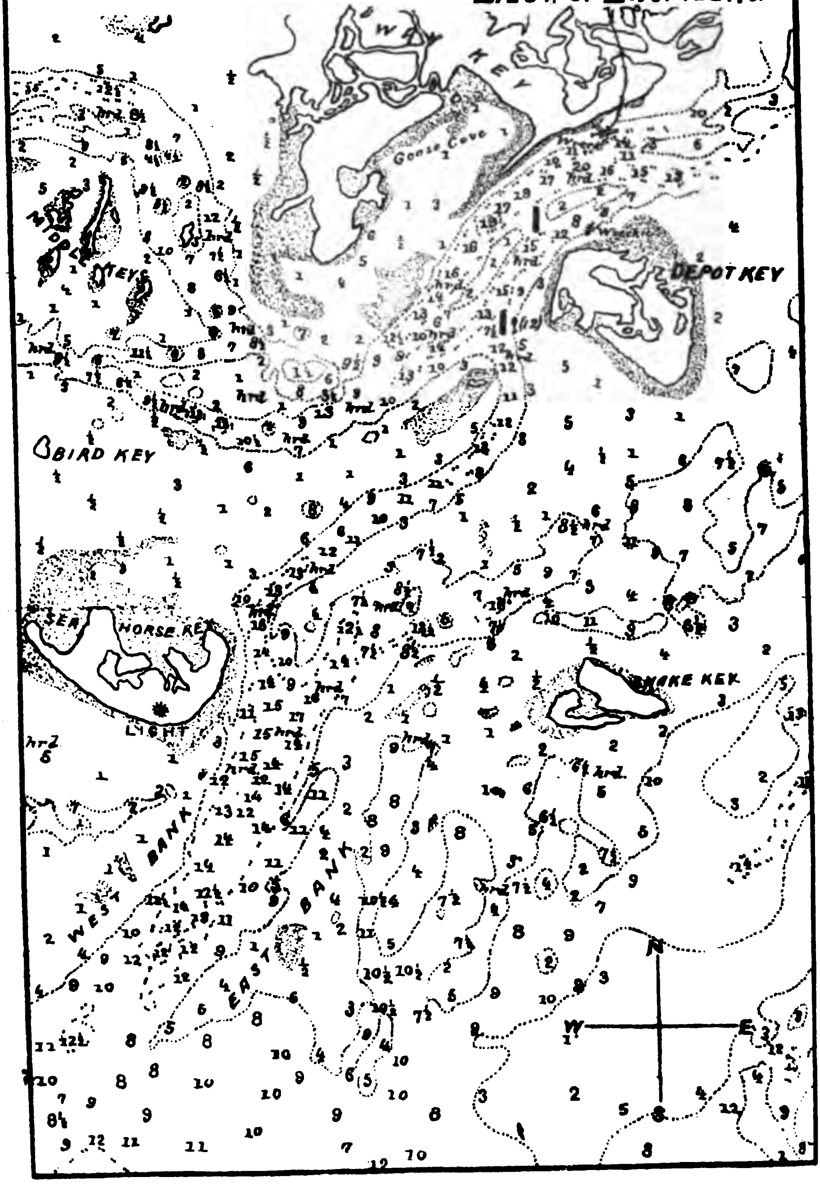
¼ ½ ¾ 1

NOTE.

THE 6 FOOT CURVES MARKED THUS ....
" 12 " " " " - - - - - - - - - -
" 18 " " " " -.. -.. -.. -.. -..
DREDGED CHANNEL " " ▬

TO ACCOMPANY ANNUAL REPORT FOR 1886.

W. M. Black.
LIEUT. OF ENGINEERS.



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THE AMERICAN GRAPHIC CO. N.Y.

PROJECT OF IMPROVEMENT.

The approved project as there described is as follows: To obtain a channel 200 feet wide and with a least depth of 10½ feet from Cedar Keys to the Gulf of Mexico. A depth of 9½ feet formerly existed in this channel. The depth is limited by the existence of beds of rock under the entire channel from 9½ to 12½ feet below mean low water, which could only be removed at greater expense than the present and prospective commerce of the port would seem to warrant.

The estimated amount of material to be removed is 22,000 cubic yards, of which at least 3,000 yards is rock. The estimated cost of the improvement is $25,000.

On this project an appropriation of $5,000 was made by act approved July 5, 1884.

No work was done under this project prior to June 30, 1885.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

Under the contract with Mr. S. N. Kimball, approved by the Chief of Engineers, United States Army, January 17, 1885, and mentioned in the last Annual Report, work was commenced on the cut near Buoy No. 12, on October 14, 1885, and stopped by the exhaustion of the appropriation December 28, 1885. Under this contract 370 cubic yards of sand and 615.3 cubic yards of stone were removed, making a channel 380 feet long (60 feet wide for 250 feet, 30 feet for 130 feet), and with an average low-water depth of 11 feet. To complete the channel at this point to 200 feet in width, and the desired depth, would require the removal of 7,800 yards more, of which one-fourth is rock.

Recent reports show that the dredged cut at this point continues clean. The shoaling continues slowly in the old cut through the middle ground, in accordance with the anticipations of the officer in charge, as reported in his annual report for 1884.

The appropriation asked for would be expended in continuing work under the present project.

From the beginning of the fiscal year the work was under the charge of Capt. W. T. Rossell, Corps of Engineers, until he was relieved by me, April 26, 1886, in accordance with paragraph 2, Special Order 89, Headquarters of the Army, Adjutant-General's Office, Washington, April 16, 1886.

Cedar Keys Harbor is in the collection district of Cedar Keys, and is a port of entry. Nearest light-house, Cedar Keys Light. Nearest fort is Fort Marion.

No revenue was collected during the fiscal year.

Money statement.

July 1, 1885, amount available	$4,802 55
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	4,802 55
Amount appropriated by act approved August 5, 1886	7,000 00
Amount (estimated) required for completion of existing project	13,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	13,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Port of Cedar Keys, Fla.

ARRIVED.

Class, &c.	Coastwise.		Foreign.	
	June 30, 1884, to June 30, 1885.	June 30, 1885, to June 30, 1886.	June 30, 1884, to June 30, 1885.	June 30, 1885, to June 30, 1886.
Steamers	12	2	4	None.
Sailing vessels	6	3	1	None.
Total tonnage	7,928	1,089	3,083	None.

CLEARED.

Steamers	13	None.	None.	None.
Sailing vessels	6	6	2	2
Total tonnage	7,422	1,498	427	587

Value of exports and imports and duties collected.	June 30, 1884, to June 30, 1885.	June 30, 1885, to June 30, 1886.
Value of exports	1,112	2,580
Value of imports	2,050	None.
Duties collected	2,090	None.

J. IRA GORE,
Special Deputy Collector of Customs.

I am indebted to Mr. Columbus Drew, of Jacksonville, Fla., for the following letter:

NEW YORK, N. Y., *June* 22, 1886.

DEAR SIR: I am in receipt of your circular of the 1st. In reply, I would say that I have a factory in Cedar Keys, Fla., for the manufacture of cedar boards for pencils and sticks for penholders. The value of the property is about $25,000, and the product 330,557 gross pencils and 23,589 gross penholders, the value of which is $48,375.29 for the year 1885.

The Eagle Pencil Company and the Joseph Dixon Crucible Company have also factories in Florida.

Yours, truly,

EBERHARD FABER.
Per O. G. BOGERT.

Mr. C. DREW,
Jacksonville, Fla.

N 10.

IMPROVEMENT OF MANATEE RIVER, FLORIDA.

Operations for the improvement of this river have been carried on under only one appropriation of $12,000, by act passed August 2, 1882.

Manatee River rises in the southern part of Florida and flows in a westerly direction, emptying into Tampa Bay on its southern shore. On its banks exist several small settlements, among which may be mentioned Palma Sola, Manatee, Braiden Town, and Hendry. Along its banks settlers have established themselves, and the amount of fruits and vegetables raised is quite large. Along its headwaters and in the country lying between it and the Caloosahatchie River and Pease Creek are found fine cattle ranges.

The shipments of lumber, fruits, vegetables, and cattle are carried on from the river.

An examination of Manatee River, with a view to its improvement, was made in 1881. A report thereon, dated February 16, 1882, with plan of improvement, is printed as part of Appendix K 25, Annual Report of the Chief of Engineers for 1882.

PROJECT OF IMPROVEMENT.

The proposed improvement consisted in forming a channel, by dredging, 100 feet wide and 13 feet deep at mean low water, from Tampa Bay to Shaw's and McNeill's points, a distance of about 4 miles. The available depth before improvement was 8 feet.

OPERATIONS UP TO JUNE 30, 1885.

Dredging was begun on this improvement March 26, 1883, and continued until April 14, 1883. It was again resumed February 18, 1884, and continued until April 25, 1884, when all work ceased, and no further work has been done, owing to lack of funds.

During this time one cut was made 2,150 feet in length, 1,750 feet of which has a width of 60 feet and a depth of 12½ feet, and 400 feet has a width of 35 feet and a depth of 12½ feet; 21,269 cubic yards of material were removed.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

On July 1, 1884, there were no funds available for this work, and no appropriation has been made since. In consequence no work has been done.

From the commencement of the fiscal year the work was under the charge of Capt. W. T. Rossell, Corps of Engineers, until he was relieved by me, April 26, 1886, in accordance with paragraph 2, Special Orders No. 89, Headquarters of the Army, Adjutant-General's Office, Washington, April 30, 1886.

It is proposed to use the appropriation asked for in extending, widening, and deepening the channel by dredging, according to the project.

Manatee River is in the collection district of Key West, which is the nearest port of entry. Nearest light-house, Egmont Key Light. Nearest fort is Fort Jefferson, Florida.

Money statement.

Amount appropriated by act approved August 5, 1886	$8,000 00
Amount (estimated) required for completion of existing project	50,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, KEY WEST, FLA.,
Collector's Office, July 20, 1886.

DEAR SIR: Acknowledging receipt of your letter under date of the 19th ultimo, to the deputy collector at Manatee, which has been referred by that officer to this office, requesting certain commercial statistics of said port, I beg to submit herewith such information as can be obtained from the records.

It will be observed that the number of vessels, steam and sail, which arrived and departed coastwise only are given. Their tonnage and crews could not be ascertained. As the law prohibits the entry or clearance of vessels to and from foreign ports at other than ports of entry, there have been no foreign arrivals or departures, imports or exports, or duties collected at the port of Manatee.

Very respectfully,

J. V. Harris,
Collector.

Lieut. W. M. Black,
Corps of Engineers.

Port of Manatee, Fla.

Coastwise.	Arrived.		Cleared.	
	June 30, 1884, to June 30, 1885.	June 30, 1885, to June 30, 1886.	June 30, 1884, to June 30, 1885.	June [illegible], 1885, to June [illegible], 1886.
Steamers	208	216	207	[illegible]
Sailing vessels	75	89	76	[illegible]

N 11.

IMPROVEMENT OF CALOOSAHATCHIE RIVER, FLORIDA.

Operations for the improvement of this river have been carried on since October 16, 1883, under appropriations made by Congress in 1882 and 1884, aggregating $10,000.

The portion of the Caloosahatchie which is proposed for improvement extends from its mouth to Fort Meyers, a distance of 14 miles.

The Caloosahatchie River rises in the Everglades of Florida, flows in a westerly direction, and empties into San Carlos Bay but a short distance above Punta Rassa. Through a great portion of its length the land is low, swampy, and unfit for use without expensive drainage. Wherever the land is high, it is rich and capable of producing fruits and vegetables. Along its banks are large cattle ranges. Punta Rassa is the shipping point for this country. This river has been connected by canal with Lake Ockeechobee, by the Ockeechobee Drainage Company, and by this canal a through inland steamboat route has been formed from Kissimee City to the Gulf.

An examination of this river, with a view to its improvement, was made in March and April, 1879. A report thereon, dated August 27, 1879, with a plan of improvement, is printed in Appendix J 17, Report of the Chief of Engineers for 1879.

PROJECT OF IMPROVEMENT.

The proposed improvement consists in deepening the channel by dredging from the mouth of the river to Fort Meyers, so as to give a depth of 7 feet at mean low water, and a width of 100 feet.

OPERATIONS UP TO JUNE 30, 1885.

Prior to this date, 6,905 cubic yards of material had been removed, clearing two miles of channel.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

The work was done under contract with S. N. Kimball, approved by the Chief of Engineers, January 17, 1885, as stated in the last annual report. Dredging was begun and finished in August. Five thousand cubic yards were removed near Jew Fish Bayou, and a clear channel 100 feet wide and 7 feet deep was obtained from the mouth to Fort Meyers, thus completing the present project.

Under this project no further appropriations are needed. Should a further improvement of the river be determined on, I would recommend that in the absence of any reliable maps a survey be first made, extending from the Punta Rassa Bar to the head of navigation. The estimated cost of the survey is $2,000.

The balance on hand will be expended in caring for the work already done.

From the beginning of the fiscal year the work was under the charge of Capt. W. T. Rossell, Corps of Engineers, until he was relieved by me April 26, 1866, in accordance with paragraph 2, Special Orders No. 89, Headquarters of the Army, Adjutant-General's Office, Washington, April 16, 1886.

The following appropriations have been made:

By act of Congress passed August 2, 1882	$5,000
By act of Congress approved July 5, 1884	5,000
Total	10,000

Caloosahatchie River is in the collection district of Key West, which is the nearest port of entry. Nearest light-house is Key West Light, and the nearest fort is Fort Taylor.

Money statement.

July 1, 1885, amount available	$4,455 29
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,911 88
July 1, 1886, amount available	543 41
Amount appropriated by act approved August 5, 1886	4,000 00
Amount available for fiscal year ending June 30, 1887	4,543 41

COMMERCIAL STATISTICS.

I am indebted to Mr. Francis M. Durrance, deputy collector and inspector of customs at Charlotte Harbor, Fla., for the following statistics:

At present a coasting steamer arrives three times per week and one from New Orleans, La., semi-monthly. Sailing vessels in coasting trade arrive almost daily. One cattle steamer of 197 tons arrives semi-monthly from Havana.

Not being a port of entry, no vessels clear from this port.

The value of exports (cattle) is about $4,000 per month.

N 12.

IMPROVEMENT OF APALACHICOLA RIVER, FLORIDA.

Operations for the improvement of this river have been carried on since December, 1874, under appropriations made by Congress in 1874, 1875, 1876, 1879, 1880, 1881, 1882, and 1884, aggregating $39,500.

The following description of the river is taken from a report made by

Assistant Engineer M. J. Mack to Captain (now Major) A. N. Damrell, Corps of Engineers, on June 7, 1883.

The Apalachicola River is formed by the junction of the Chattahoochee and Flint rivers, at the southwestern corner of the State of Georgia, and runs in a southerly direction through the State of Florida, emptying into Saint George's Sound at the city of Apalachicola, passing through a very low swampy country, which is annually overflowed by the freshets from the Chattahoochee and Flint rivers, rendering the land comparatively useless for agricultural purposes for a great distance on either side. There is, however, a quantity of fine timber, mostly cypress and pine, along its banks, and as it has a number of tributaries extending far into the country, among them Chipola River, Canada, Owl, Fort Gadson, Smith, and Brinsley creeks, a fine means is given of rafting it to Apalachicola, where two (now four) mills of large capacity are kept in constant operation.

The importance of this river has increased since then by a steady growth of the settlement along its banks, especially of the town of Apalachicola at its mouth.

Cotton is grown along the banks and turpentine and resin shipped.

PROJECT OF IMPROVEMENT.

The project consists in securing a channel 100 feet wide and 6 feet deep at low water, by removing snags and overhanging trees, as well as widening and straightening Moccasin Slough.

OPERATIONS UP TO JUNE 30, 1885.

This improvement was commenced in December, 1874, the steamboat Clara Dunning being employed in removing logs and overhanging trees.

The depth of water was sufficient, as well as the general width from bank to bank, but its availability for purposes of commerce was bad in consequence of numerous snags.

The river at Virginia Bend, 50 miles above Apalachicola, was completely closed for a distance of 6 miles, and the only chance for navigation was through Moccasin Slough, which was very crooked, narrow, and badly obstructed with overhanging timber, so much so that it required several days for a boat, with the use of lines, to pull through.

The original project for improvement contemplated a channel 100 feet wide and 6 feet deep at low water, to be secured by removing snags and overhanging trees, as well as widening and straightening Moccasin Slough, and no change has been made in the original design.

In addition to the original project, Chipola Cut-off has been opened to White's Bluff, on Chipola River, a distance of 9 miles.

The improvement may be considered as completed as projected, the river being in good navigable condition, and only requiring the removal of the annual accumulation of snags and overhanging trees, and such work as can be done with the amount of $2,000, which has been estimated as necessary annually for preserving the improvement.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

From the commencement of the fiscal year the work was under the charge of Capt. W. T. Rossell, Corps of Engineers, until he was relieved by me April 26, 1886, in accordance with paragraph 2, Special Orders No. 89, Headquarters of the Army, Adjutant-General's Office, Washington, April 16, 1886.

Work was done during August and September by hired labor, using the United States snag-boat belonging to the Pease Creek improvement and a hired steamboat for towing.

The boat arrived August 10, and work was begun at a point about 1½ miles above Moccasin Slough, and had progressed up the river about a mile, when a rise in the river made further effective work impossible for the time. The appropriation being nearly exhausted it was determined to stop for the season. The snag-boat was towed back to the Withlacoochee River, and there laid up September 29. During the operations 110 snags and logs, varying in length from 40 to 80 feet, were removed.

The following appropriations have been made:

By act of Congress approved June 23, 1874	$10,000
By act of Congress approved March 3, 1875	10,000
By act of Congress approved June 18, 1878	8,000
By act of Congress approved March 3, 1879	5,000
By act of Congress approved June 14, 1880	2,000
By act of Congress approved March 3, 1881	1,500
By act of Congress passed August 2, 1882	2,000
By act of Congress approved July 5, 1884	1,000
Total	39,500

The balance available and the appropriation asked are to be used in preserving the improvement by the removal of obstructions according to project.

Apalachicola River is in the collection district of Apalachicola, which is the nearest port of entry. Nearest light-house, Cape Saint George Light. Nearest fort, defenses of Pensacola, Fla. Amount of revenue collected during fiscal year, $1,320.

COMMERCIAL STATISTICS.

For commercial statistics, see Annual Report, on improvement of Apalachicola Bay, Florida.

Money statement.

July 1, 1885, amount available		$2,255 49
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$2,072 81	
July 1, 1886, outstanding liabilities	65 90	
		2,138 71
July 1, 1886, amount available		116 78
Amount appropriated by act approved August 5, 1886		1,000 00
Amount available for fiscal year ending June 30, 1887		1,116 78
Amount (estimated) required for preservation of improvement, annually		2,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		2,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

N 13.

IMPROVEMENT OF WITHLACOOCHEE RIVER, FLORIDA.

Operations for the improvement of this river have been carried on in accordance with the project submitted to the Chief of Engineers by the officer then in charge, in 1879, and published as part of Appendix K 8 to the Annual Report of the Chief of Engineers for 1880.

The project adopted is to improve the river by the removal of snags, overhanging trees, and loose rocks, and by deepening of some of the worst shoals and a bar at the mouth of the river, so as to enable boats drawing 2 feet to navigate the river during about half the year from the mouth to Hay's Ferry, a distance of 100 miles.

The original depth of the river was from 1 to 7½ feet, with a width of from 75 to 150 feet.

OPERATIONS PRIOR TO JUNE 30, 1885.

Under the appropriations a suitable snag-boat had been built and equipped and the river had been gone over, removing some of the worst shoals. A navigable channel now exists from the mouth to Morrison's landing, a distance of 30 miles.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1886.

No work has been done during the year, owing to the small balance of the appropriation remaining on hand.

From the commencement of the fiscal year the work was under the charge of Capt. W. T. Rossell, Corps of Engineers, until he was relieved by me, April 26, 1886, in accordance with paragraph 2, Special Orders No. 89, Headquarters of the Army, Adjutant-General's Office, Washington, April 16, 1886.

It is proposed to extend the improvement up to Fort Dade.

The upper river has been reached by two railroads, the Florida Southern and the Florida Transit and Peninsula, thus increasing its importance. The principal industry is the raising and shipping of fruits and vegetables. The arrival of the railroads has given a great impetus to this business, and they seek the river as means of transportation to the roads.

The money now available is to be used for the care and preservation of the public property.

The appropriation asked for is to be applied to extending the improvement under the existing project.

The following appropriations have been made:

By act of Congress approved March 3, 1881	$7,500
By act of Congress approved July 5, 1884	3,000
Total	10,500

Withlacoochee River is in the collection district of Cedar Keys, Fla., which is the nearest port of entry. Nearest light-house, Cedar Keys Light. Nearest fort is Fort Marion, Florida.

Money statement.

July 1, 1885, amount available	$428 80
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	272 00
July 1, 1886, amount available	156 80
Amount appropriated by act approved August 5, 1886	3,000 00
Amount available for fiscal year ending June 30, 1887	3,156 80
Amount (estimated) required for completion of existing project	10,400 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,400 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

N 14.

REMOVAL OF SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Removal of the wreck of the steamer Dictator.—This was a wooden side-wheel steamer, of 512 tons, built at Brooklyn, N. Y., 1863. It was burned to the water's edge in the harbor of Tampa December 26, 1883, and the hull and machinery lay near Spanish Town Point, in the edge of the main ship-channel.

It having been reported as an obstruction to navigation, the Honorable Secretary of War directed that the proper steps should be taken for its removal. Due notice to the owners, in accordance with law, was published in February, 1885.

OPERATIONS DURING THE PAST FISCAL YEAR.

On November 12, 1885, proposals for the removal of the wreck were opened. Messrs. William H. Brown and George Theodore, of New Orleans, La., were the lowest bidders, and the contract was awarded to them for $2,500.

The agreement states, "Work of removal is to be commenced on or before December 11, 1885, and is to be completed on or before February 1, 1886." After numerous delays operations under the contract began January 13, 1886. Work progressed very slowly, and there were numerous disagreements between the contractors. On February 25 the contractors finally disagreed, and one of them abandoned the work.

On April 8, 1886, authority was given by the Chief of Engineers, United States Army, to annul the contract, the time for its completion having expired.

The work was readvertised, and proposals opened June 17. Messrs. Charles H. Schenck and Nicholas Theodore, the lowest bidders, were awarded the contract for $2,500, and the necessary papers are now being prepared.

On April 26 Captain Rossell transferred the charge of this work to me, by virtue of paragraph 2, Special Orders, No. 89, Headquarters of the Army, Adjutant-General's Office, Washington, April 16, 1886.

Removal of sunken scow from harbor at Tampa, Florida.—On August 29 Captain Rossell reported that a scow, sunk during the war across the main channel near Spanish Town Point, was an obstruction to navigation. In letter of September 9, the necessary steps for its removal were directed. On September 25, the required public notice was given. After advertisement, on December 20, proposals for the removal of the scow were opened. Messrs. W. H. Brown and George Theodore, the lowest bidders, were awarded the contract for $750. Subsequently, before the contract was made, Mr. Theodore withdrew, and the contract was entered into with Mr. Brown alone.

Operations under it commenced May 3, and were concluded May 17, all of the scow having ben removed.

On April 26, Captain Rossell transferred the charge of this work to me, by virtue of paragraph 2, Special Orders, No. 89, Headquarters of the Army, Adjutant-General's Office, Washington, April 16, 1886.

Abstract of proposals for removing wreck of the steamer Dictator, now lying in harbor at Tampa, received and opened by Capt. William T. Rossell, Corps of Engineers, November 12, 1885.

No.	Names of bidders.	Amount.	Remarks.
1	E. A. McDonald	$15,000	
2	J. Francis Le Baron	3,700	
3	W. E. Chapman	9,980	
4	W. H. Brown and George Theodore	2,500	Lowest bid. Guarantee signed by bidders.
5	John H. Gardner	3,874	Instructions to bidders not attached to proposal.
6	R. G. Ross	4,300	

Contract awarded to William H. Brown and George Theodore, November 30, 1885. Contract annulled April 8, 1886.

Abstract of proposals for removing sunken scow from harbor at Tampa, Fla., received and opened by Capt. William T. Rossell, Corps of Engineers, December 20, 1885.

No.	Names of bidders.	Amount.	Remarks.
1	William H. Brown and George Theodore	$750	Lowest bid.
2	Rittenhouse Moore	2,250	

Contract awarded to W. H. Brown. Operations commenced May 3, 1886. Contract completed May 17, 1886.

Abstract of proposals for removing wreck of steamer Dictator now lying in harbor at Tampa, Fla., received and opened by Lieut. W. M. Black, Corps of Engineers, June 17, 1886.

No.	Names of bidders.	Amount.	Remarks.
1	T. N. Anderson and H. Jackson	$5,945	
2	L. S. Dawes and W. H. Brown	4,000	
3	American Dredging Company	6,800	
4	C. H. Schenck and N. Theodore	2,500	Lowest bid.
5	William E. Chapman	7,480	
6	Roderick G. Ross	3,300	
7	S. N. Kimball	5,900	
8	Cresent City Wrecking Company	6,500	

Contract awarded to C. H. Schenck and N. Theodore. Operations to commence August 2, 1886, to be completed September 2, 1886.

APPENDIX O.

IMPROVEMENT OF CERTAIN RIVERS IN THE STATES OF GEORGIA, FLORIDA, AND ALABAMA—IMPROVEMENT OF THE HARBOR AT PENSACOLA, FLORIDA.

REPORT OF CAPTAIN R. L. HOXIE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Ocmulgee River, Georgia.
2. Oconee River, Georgia.
3. Flint River, Georgia.
4. Oostenaula and Coosawattee rivers, Georgia.
5. Coosa River, Georgia and Alabama.
6. Chattahoochee River, Georgia and Alabama.
7. Alabama River, Alabama.
8. Tallapoosa River, Alabama.
9. Cahaba River, Alabama.
10. Conecuh—Escambia river, Florida and Alabama.
11. Choctawhatchee River, Florida and Alabama.
12. Bayou La Grange, Florida.
13. Harbor at Pensacola, Florida.

UNITED STATES ENGINEER OFFICE,
Montgomery, Ala., August 10, 1886.

GENERAL: I have the honor to transmit herewith annual reports upon the river and harbor improvements under my charge for the fiscal year ending June 30, 1886.

Very respectfully, your obedient servant,

R. L. HOXIE,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

O 1.

IMPROVEMENT OF OCMULGEE RIVER, GEORGIA.

The Ocmulgee River rises in the northwestern part of Georgia, flows past the towns of Macon, Ga., and Hawkinsville, Ga., and unites with the Oconee River about 10 miles below Lumber City, to form the Altamaha. The State of Georgia has expended about $60,000 for the improvement of this river. The first examination and survey by authority of the United States was made in 1852, and another in 1875. Subsequent to this a plan of improvement was adopted which contemplates the removal of obstructions from the channel, and cutting through rock shoals so as to obtain a navigable channel 60 feet in width and 4 feet in depth at low water from Macon, Ga., to the Oconee River.

The expenditure of $57,000 up to the present time under the adopted plan of improvement has resulted in securing navigation of the river at a stage from 2 to 3 feet lower than was practicable before the commencement of the improvement.

The work done during the past fiscal year was as follows:

Number of overhanging trees felled and cut up	585
Number of logs on bank cut up	15
Number of stumps on bank cut level	54
Number of logs and snags removed from river	611

At the close of last season's work it was found that the snagboat in use on this improvement was completely worn out, not worth repairing and not worth the cost of keeping over for another season. At the same time the appropriation was exhausted; it was therefore concluded to condemn the boat, and it was sold at public auction in November, 1885, leaving the improvement without any working plant.

Before work can be resumed, it will be necessary to provide a working plant, and it is recommended that this be a steam snagboat of small size, costing, with her equipment, about $10,000, to be used in common for the Ocmulgee and Oconee rivers.

The appropriation asked for can be profitably expended in the construction of this snagboat, paying one-half the cost, and in continuing the work of removing obstructions from the river channel.

During the past season the work has been in charge of Assistant Engineer C. A. Locke to September 11, 1885, and of F. C. Armstrong to October 31, 1885.

There is no working plant upon this improvement, but one-half the value of the working plant to be provided for this river, in common with the Oconee River, is estimated at $5,000. When worked to its full capacity for one-half the working season, an annual expenditure of $15,000 is required; a less expenditure with such working plant is injudicious. With an increase of working plant about $25,000 can be profitably expended during the fiscal year ending June 30, 1888.

The original estimate of cost of this improvement is $112,480. To this must be added the cost of removing obstructions brought into the channel since the date of this estimate by the annual freshets. This river has a movable bottom and caving banks which are covered with timber. The improvement will have that degree of permanence which attaches to works of contraction under such circumstances. An annual expenditure will be required for the maintenance of the work and the removal of fresh obstructions.

The census of 1880 gives, for the counties bordering upon this river within the limits of the proposed improvements, a total assessed valuation of real and personal property amounting to $17,876,408, and a total taxation of $272,180.

Money statement.

July 1, 1885, amount available	$2,376 61
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,376 61
Amount appropriated by act approved August 5, 1886	7,500 00
Amount available for fiscal year ending June 30, 1887	7,500 00
Amount (estimated) required for completion of existing project	48,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	25,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

An effort has been made to obtain commercial statistics from parties presumably in the navigation of this river, but none have been received. In 1885 the following named steamboats were employed in the navigation of the river:

Ida, Colville, Mary Jeter, Wadley, Mary Cooper, North State, and Cumberland. These boats then carried about 6,800 barrels of turpentine, 28,000 barrels rosin, and about 3,200 tons of cotton, provisions, &c. In addition to this about 30,000,000 feet of lumber(B. M.) was rafted down the river.

O 2.

IMPROVEMENT OF OCONEE RIVER, GEORGIA.

This river rises in Northeast Georgia, flows past the towns of Milledgeville and Dublin, Ga., and joins the Ocmulgee in the southern part of the State, forming the Altamaha. The State of Georgia has expended about $35,000 for its improvement. The first examination of the river, by authority of the United States, was made in 1874, and a plan of improvement adopted, contemplating the removal of obstructions from the channel, and blasting through rock reefs where necessary, in order to secure a depth of about 3 feet at low water from Milledgeville to the Ocmulgee River. The work done up to the present time, under this plan of improvement, at an expenditure of $23,499.22, has resulted in enabling steamboats to navigate the river at a stage of water 4 feet lower than that at which navigation was practicable before the improvement was commenced.

No work was done during the past fiscal year owing to the exhaustion of the appropriation for this improvement.

At the close of last season's work it was found that the snag-boat in use on this improvement was completely worn out; not worth repairing, and not worth the cost of keeping over for another season. It was therefore concluded to condemn the boat, and it was sold at public auction in November, 1885, leaving the improvement without any working plant.

Before work can be resumed it will be necessary to provide a working plant; and it is recommended that this be a steam snag-boat of small size, costing, with her equipment, about $10,000, to be used in common for the Oconee and Ocmulgee rivers.

The appropriation asked for can be profitably expended in the construction of this snag-boat, paying one-half the cost, and in continuing the work of removing obstructions from the river channel.

There is no working plant upon this improvement, but one-half the value of the working plant to be provided for this river, in common with the Ocmulgee River, is estimated at $5,000. When worked to its full capacity for one-half the working season, an annual expenditure of $15,000 is required; a less expenditure, with such working plant, is injudicious. With an increase of working plant, about $25,000 can be profitably expended during the fiscal year ending June 30, 1888.

The original estimate of cost of this improvement is $50,000. To this must be added the cost of removing obstructions brought into the river channel by freshets since the date of the estimate. The river has generally a movable bottom and caving banks covered with timber. The improvement will have that degree of permanence which attaches to works of contraction in such a stream. An annual expenditure will be required for the removal of fresh obstructions and the maintenance of the work.

The census of 1880 gives, for the counties bordering upon this river within the limits of the proposed improvement, a total assessed valuation of real and personal property amounting to $7,475,214, and a total taxation of $99,973.

Money statement.

July 1, 1885, amount available	$352 22
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	351 44
July 1, 1886, amount available	78
Amount appropriated by act approved August 5, 1886	9,000 00
Amount available for fiscal year ending June 30, 1887	9,000 78
Amount (estimated) required for completion of existing project	17,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	17,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

An effort has been made to obtain commercial statistics from parties presumably interested in the navigation of this river, but without success.

In 1885 the following-named steamboats were employed upon this river:

	Tons.
Laurens	180
Wadley	190
Ida	250
Mary Cooper	150
North State	180

These boats carried during that year about 4,400 barrels of turpentine and about 6,000 tons cotton, merchandise, provisions, &c., besides which about 20,000,000 feet of lumber were rafted down the river.

O 3.

IMPROVEMENT OF FLINT RIVER, GEORGIA.

This river rises in the western part of Georgia near the city of Atlanta. It flows past Montezuma, Albany, Newton, and other towns to Chattahoochee, Fla., where it unites with the Chattahoochee to form the Apalachicola River. The plan of improvement made pursuant to an examination and survey of the river in 1872 and 1873, modified after further examination in 1880, contemplates a low-water navigable channel 3 feet in depth and 100 feet in width, from the mouth of the river to Albany, Ga., a distance of 105 miles, and a navigable channel for light-draught steamers at a moderate stage of water from Albany to Montezuma, an estimated distance of 100 miles. The work to be done consists in the removal of snags and other obstructions from the channel and overhanging trees from the banks, the scouring of bars by works of contraction, and cutting of the prescribed channel through the rock-reefs.

The expenditure up to the present time of $94,919.87, has resulted in securing a fair navigable channel at low water from Chattahoochee to Tea Cup Shoals, about 19 miles below Albany, at which point operations were suspended at the close of last working season, and an improved high-water channel between Montezuma and Warwick, 40 miles above Albany.

During the past fiscal year a small hand-power snag-boat was kept at work on the river between Montezuma and Warwick removing logs and cutting overhanging trees, effecting the removal of 814 snags and overhanging trees; and a number of drilling-scows on the reefs about 19 miles below Albany were engaged in effecting the removal of 5,477 cubic yards of rock, and 440 snags and overhanging trees.

The following table shows the condition of the improvement on June 30, 1886:

Table showing condition of improvement on June 30, 1886.

Names of places.	Number of places improved.	Below Albany.	Original depth.	Present depth.	Original width.	Present width.	Number of cubic yards of rock removed from each place.	Remarks.
		Miles.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Cu. yds.*	
Lambert's Island	1	88	1	3	0	100	67	New channel blasted. Dry bowlder removed.
Rob's Rock	2	85	0	2	60	100	152	Bowlder in mid-channel removed.
Broadaxe Rock	3	84½	½	4	50	100	43	Bowlder on point removed.
Bryant's Rock	4	79½	½	4	70	100	54	Bowlder in mid-channel removed.
Versailles Rock	5	77	½	4	50	100	415	Several reefs removed.
Town of Bainbridge	6	75	1	4	100	100		Do.
Three Rock Reach	7	72	½	4	40	100	122	Loose rocks and bowlders removed.
Below Cross Chute	8	71	½	4	30	100	1,171	Do.
Cross Chute	9	64	0	4	75	100	120	Dry ledge removed to widen channel.
Fodder Stack	10	63	0	3	80	100	483	Do.
Reefs No. 1 to No. 12	11 to 22	63 to 54	1 1	3 3	40	100	1,372	Loose rock, large bowlders, and solid reefs removed.
Crawford's Point	23	54	0	3	70	100	1,231	Dry ledge and bowlders removed.
Winding Shoals	24	53	1	3	40	100	897	Loose rock and solid ledges removed.
Hell Gate Shoals	25	51½	0	3	0	100	3,636	New channel blasted through solid rock.
Sycamore Shoals	26	51	1	3	40	100	315	Loose rocks, solid ledges blasted and removed.
Maple's Chute	27	50½	0	3	20	100	2,151	New channel blasted, cut-off made, and island removed.
Keaton's Lower Shoal	28	48¾	1	3	20	100	86	Large bowlders and loose rocks removed.
Keaton's Middle Shoal	29	48½	0	3	20	100	214	Do.
Keaton's Upper Shoal	30	48¼	0	3	....	75	145	Do.
Dubignign's Shoal	31	48	0	3	....	90	258	Do.
Lyon's Island	32	44	2	3	....	75	92	Solid ledge and loose rocks removed.
Fishtrap Shoals	33	43½	2	3	....	100	285	Do.
Bull's Slough	34	41½	1½	3	....	100	562	Do.
Ropework Shoals	35	41	1	4	50	50	554	Do.
Drybread Reef No. 3	36	40¼	½	5	25	75	440	Do.
Drybread Reef No. 2	37	39¾	2	3	20	80	631	Do.
Drybread Reef No. 1	38	39½	2	5	20	80	134	Do.
Dickerson's Shoals	39	39¼	2	3	40	80	83	Large bowlders and loose rocks removed.
Buck Shoals	40	37¾	2	4	30	100	105	Do.
Sisters Islands	41	36½	1½	4	40	100	312	Solid ledge and loose rocks removed.
Kenedy's Shoals	42	35½	1	3	30	100	103	Do.
Newton	43	33¼	1	3	30	100	141	Large bowlders and part of island removed.
Between Newton and Ferguson's.	44	31¼	2	3	50	100	40	One large bowlder removed.
Ferguson's Shoals	45	22½	1½	3	20	80	3,598	Five distinct reefs, 1 mile in length, of loose rock and solid ledges removed.
Luckie's Island	46	21	1½	3	30	100	838	Point of rock island cut off and bowlders removed.
Tea Cup Shoals	47	19½	2	3	....	....	1,555	Three separate reefs, loose rock, and bowlders removed; not completed.

The funds remaining on hand and the appropriation asked for can be profitably expended in continuing the work of cutting through rock shoals below Albany, and in removing obstructions from the river channel between Albany and Montezuma. The work has been in charge of Assistant Engineer P. M. Slaughter.

The value of the working plant upon this improvement is estimated at $1,727. When worked to its full capacity an annual expenditure of $20,000 is required; a less expenditure, with the present working plant, is injudicious. With an increase of working plant about $40,000 can be profitably expended during the fiscal year ending June 30, 1888.

The original estimate of cost of this improvement is, from Chattahoochee, Fla., to Albany, Ga., $184,862; from Albany to Montezuma, Ga., $15,000. To the latter estimate should be added the cost of removing the annual accumulation of obstructions due to freshets in the upper river; this requires a constant annual expenditure. For the lower river the work is principally upon the rock bottom of the river, and is of a permanent character.

The census of 1880 gives for the counties bordering upon this river within the limits of the proposed improvement a total assessed valuation of real and personal property amounting to $13,451,611, and a total taxation of $156,016.

Money statement.

July 1, 1885, amount available		$14,449 27
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$12,339 38	
July 1, 1886, outstanding liabilities	163 00	
		12,502 38
July 1, 1886, amount available		1,946 89
Amount appropriated by act approved August 5, 1886		20,000 00
Amount available for fiscal year ending June 30, 1887		21,946 89
Amount (estimated) required for completion of existing project		83,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		40,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

Number of boats employed in the commerce of this river	10
Valuation	$126,000
Tonnage	1,400
Draught in feet	2 to 5

During the year ending June 30, 1886, these boats carried in freight as follows:

Commercial fertilizers	tons	6,542
Iron	do	206
Cotton	bales	22,760
Grain	bushels	27,680
Lumber	feet	4,730,000
Merchandise	bales	760
Merchandise	barrels	189,700
Live stock	number head	64
Turpentine	barrels	3,000
Resin	do	15,000
Square and round timber (by raft)	feet	3,000,000

Total valuation	$3,185,274
Total valuation of freights	40,700
Total valuation of passenger traffic	27,000
Aggregate valuation of river business	3,252,974
Aggregate value in 1885	3,234,163

The large increase in our river business for the present year is mainly caused by the improved condition of the river as caused by Government appropriations, thus enabling our boats to run the year through, and, by connections with railroad points below, to offer through rates for cotton and merchandise to and from all points east and north in competition with our local railroads, thus increasing very materially the amount of business to our boats, and enabling the merchants on the river to compete in freights with other points not so favorably located.

C. E. HOCHSTRASSER,
Vice-President Columbus Board of Trade.
E. L. WELLS,
Secretary Columbus Board of Trade.

COLUMBUS, GA., *July*, 1886.

O 4.

IMPROVEMENT OF OOSTENAULA AND COOSAWATTEE RIVERS, GEORGIA.

No work has been done on either of these rivers during the fiscal year ending June 30, 1886, nor in fact since active operations were suspended on the Coosawattee in October, 1880, and on the Oostenaula in August, 1881.

As there is now a fair channel for light navigation at moderate stages of the water, no further appropriation appears to be demanded by the interests of commerce.

Money statement.

July 1, 1885, amount available		$1,163 71
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$20 00	
July 1, 1886, outstanding liabilities	21 85	
		41 85
July 1, 1886, amount available		1,121 86

O 5.

IMPROVEMENT OF COOSA RIVER, GEORGIA AND ALABAMA.

In 1823 the State of Alabama passed an act to aid the improvement of the Coosa River. In 1828 Congress provided that any surplus of the grant for the Tennessee River should be applied to the improvement of the navigation of the Coosa and other rivers. In 1870 an act of Congress authorized an examination of the Coosa River between Greensport and the Selma, Rome and Dalton Railroad Bridge, a distance of 77 miles, and in 1872 an instrumental survey of this part of the river, upon which to base plans and estimates for its improvement. In 1875 an examination of the river was made from Rome, Ga., to Gadsden, Ala., a distance of 135 miles, when a plan for its improvement was adopted, which was subsequently modified, providing for a channel 30 feet wide and 3 feet deep at extreme low water.

In 1876 an appropriation was made for improving the Coosa River between Rome and the Selma, Rome and Dalton Railroad Bridge, which dates the beginning of the improvement of this river according to the present project. This project contemplates the improvement of the river between these points, overcoming the more serious obstructions by locks and dams and the lesser rock shoals and sand and gravel bars by rock excavation and by works of contraction respectively. This plan has been carried out to the present time without material change or modification.

This river has been navigated continuously between Rome and Greensport since 1847, during high water, a distance of about 130 miles, the obstructions consisting of the lesser shoals and bars. Just below Greensport the Ten Island Shoals offered the most serious obstruction, giving a fall at low water of 24 feet in a distance of about 2 miles.

The expenditure of $417,396.06 up to the present time has resulted in the improvement of the water channel above Greensport by straightening it and widening it and increasing the depth from 16 inches to a minimum of 2 feet. Below Greensport the work of lock and dam navigation to overcome the more serious obstructions is nearly completed. This will open the river to navigation as far down as the head of Broken Arrow Shoals, and was nearly completed during the past season when the exhaustion of the appropriation compelled the abrupt cessation of work.

During the past season, with the limited appropriation available, work has been done as follows:

	Cubic yards.
Earth removed at quarry	266
Stone quarried	794
Stone dressed	261
Stone transferred from quarry to river	714
Channel excavated (rock)	143

The condition of the work on June 30, 1886, was as follows:

Lock No. 1: Lock and dam completed and gates set up.

Lock No. 2: Masonry for lock and dam completed and gates framed.

Lock No. 3: Masonry for lock (except coping) and dams completed and gates framed.

Lock No. 4: Stone quarried and dressed, except coping.

During the month of April, 1886, the Coosa River, in the vicinity of this work, rose to a height of 6½ feet above the highest known water-mark up to that time. Very little damage was done to the work beyond the floating off of some of the gate-timbers, the greater part of which were recovered, and dislodging a small quantity of riprap-stone. The total damage is estimated at $1,100.

This work has been in charge of Assistant Engineer M. T. Singleton.

The funds remaining on hand, together with the appropriation asked for, can be profitably expended during the fiscal year ending June 30, 1888, in continuing the improvement between Rome, Ga., and the Selma, Rome and Dalton Railroad Bridge, Alabama.

The value of the working plant upon this improvement is estimated at $6,895, but the work is of such character that a trifling increase in the plant is sufficient to increase very greatly the amount of work. With the present working plant, worked to its full capacity, an annual expenditure of $75,000 is required; a less expenditure with the present working plant is injudicious. With an increase of plant, the completion of the work within the limits of the present project can be effected by an expenditure of $150,000, unless extraordinary delays should be incurred in the acquisition of title to the land.

The original estimate of cost of this improvement is $560,663. To this must be added the cost of improving about 29 miles of the river between Greensport and Gadsden, not included in any survey or estimate; also the increased cost of the better class of work adopted in the construction of the locks and dams, as well as the cost of removing obstructions which accumulate annually in the river channel, and the maintenance of the works. Below Greensport the improvement is of a permanent character, consisting of locks and dams. Above Greensport the river has generally a moderate slope and banks not easily eroded, but in places a movable bottom, where works of contraction are required. The improvement of this part of the river will have that degree of permanence which attaches to works of contraction under such circumstances. An annual expenditure will be required for removing obstructions from the channel and for maintaining the works.

The census of 1880 gives, for the counties bordering upon this river, within the limits of the proposed improvement, a total assessed valuation of real and personal property amounting to $15,232,350 and a total taxation of $199,878.

The primary object of this improvement is to open the river from Rome to the Coosa coal-fields, in the vicinity of Broken Arrow. The present local business on the river is therefore an incomplete exhibit of the importance of this improvement.

Money statement.

July 1, 1885, amount available		$21,862 12
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$21,058 18	
July 1, 1886, outstanding liabilities	1,254 41	
		22,312 59
Amount appropriated by act approved August 5, 1886		45,000 00
Amount (estimated) required for completion of existing project		96,968 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		97,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

An effort has been made to obtain commercial statistics from parties presumably interested in the navigation of this river; but no information has been received. The statistics for 1885 are as follows:

The following is a list of the boats employed on the river:

Name.	Length at water-line.	Beam.	Tonnage.
	Feet.	*Feet.*	
Sidney P. Smith	137	23	83.40
Gadsden	164	80	133.66
Joel Marable	140	20	97.75
Hill City	140	18	75.75
To be completed by September 15, 1885	175	84	250.00

During the year ending June 30, 1885, these boats carried freight as follows:

Cotton	bales..	$25,000
Grain, hay, and flour	tons..	3,500
Guano	do...	2,500
Miscellaneous merchandise	do...	5,000
Lumber	B. M., feet..	4,500,000
Passengers	number..	8,500

In addition to the above, about 24,000,000 feet, B. M., yellow pine lumber was rafted to the mills on the river.

O 6.

IMPROVEMENT OF THE CHATTAHOOCHEE RIVER, GEORGIA AND ALABAMA.

The Chattahoochee River rises in the northern part of Georgia, flowing past the town of Columbus, the proposed head of navigation, where the river forms the boundary line between Georgia and Alabama, and the town of Eufaula and other towns to Chattahoochee, Fla., where it unites with the Flint River to form the Apalachicola. The present plan of improvement, adopted in 1873, contemplates a low-water channel 4 feet in depth and 100 feet in width from Columbus, Ga., to Chattahoochee, Fla., a distance of 223½ miles by the removal of snags and other obstructions from the channel and overhanging trees from the banks, by cutting a channel through the rock shoals and deepening sand-bars by scour.

The expenditure up to the present time of $188,857.40 has resulted in securing a fair navigable channel between Chattahoochee and Eufaula at all seasons of the year, and between Eufaula and Columbus at all times except during the prevalence of extreme low water.

The following table exhibits the condition of the improvement on June 30, 1886:

Table showing the condition of the improvement on June 30, 1886.

Number of shoal.	Name of place.	Below Columbus, Ga.	Above Chattahoochee, Fla.	Original depth.	Present depth.	Original width.	Present width.	Remarks.
		Miles.	*Miles.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	South Commons	1	323	2	4	300	100	Brush jetties.
2	Mound Bar	7	217	2½	4	350	150	Do.
3	Abercrombie's Bar	8	216	1½	4	350	150	Do.
4	Woolfolk's Bar	10	214	1½	4	500	150	Brush jetties and shore protections.
5	Upatoie	11	213	2	4	300	150	Brush.
6	Little Shoals (Uchee)...	17	207	2	4	29	65	Marl blasted and removed.
7	Reef below shoal	17½	206½	1½	4	50	60	Do.
8	Slick Bluff Shoal	18	206	0	4	39	70	Do.
9	Middle Rock	18½	205½	1½	4	30	100	Do.
10	Big Uchee Shoal	19	205	1½	4	29	80	Do.
11	Old Head of Uchee	19½	204½	1½	4	40	......	Do.
12	Betton's Upper Rocks..	20½	203½	......	4	40	180	Hard rocks blasted and removed.
13	Betton's Lower Rocks .	21	203	......	4	50	200	Do.
14	Cody's Rocks	22	202	1	4	40	100	Do.
15	Shell Creek Bar	24	200	3	3	350	350	Shore protection.
16	Culpepper's Island	32	192	2	4	400	100	Jetties, marl reef blasted and removed.
17	Hardridge's Shoal	112	111	2	4	35	100	Hard rock blasted and removed.

Numbers 6, 7, 8, 9, 10, and 11 constitute Uchee Shoals, about 3 miles long, number 11 being worked on at close of the season.

During the past fiscal year a new steam snag-boat has been completed and equipped for work on the Chattahoochee River at a total cost of $12,000, the engines, machinery, and other parts of the old boat having been introduced into the new one, except such as were found to be worthless.

Forty-six logs, snags, and trees were removed from the channel. The principal work done has been the excavation of a channel through

Uchee Shoals, where 4,473½ cubic yards of rock and 11 cubic yards of sand have been removed, the distance worked over at that point being 5,000 feet.

The funds remaining on hand, together with the appropriation asked for, can be profitably expended in continuing the work of excavation upon the rock-reef between Eufaula and Columbus, and in the employment of the new snag-boat for the removal of logs and other obstructions. The work has been in charge of Assistant Engineer P. M. Slaughter.

The value of the working plant upon this improvement is estimated at $20,002. When worked to its full capacity an annual expenditure of $20,000 is required; a less expenditure with the present working plant is injudicious. With an increase of plant about $40,000 can be profitably expended during the fiscal year ending June 30, 1888.

The original estimate of cost of this improvement is $385,247.66. The limited appropriations available have compelled slow progress of the work, and have added the annual accumulation of obstructions, due to freshets in the river, to the amount of work contemplated in the original estimate. There has also been added the cost of maintenance of works of contraction, and of their extension, made necessary by the works themselves.

This improvement is at several points of a permanent character, the bottom of the river being of rock, and the banks not subject to erosion. At other points the river has a movable bottom and caving banks, and the improvement will have, with an annual expenditure for maintenance and repair, that degree of permanence which works of contraction can give to such a stream.

The census of 1880 gives for the counties bordering upon this river within the limits of its contemplated improvement, a total assessed valuation of property, real and personal, of $20,272,775, and a total taxation of $271,573.

Money statement.

July 1, 1885, amount available		$30,755 65
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$16,594 08	
July 1, 1886, outstanding liabilities	5,095 87	
		21,989 95
July 1, 1886, amount available		9,065 70
Amount appropriated by act approved August 5, 1886		20,000 00
Amount available for fiscal year ending June 30, 1886		29,065 70
Amount (estimated) required for completion of existing project		162,228 69
Amount that can be profitably expended in fiscal year ending June 30, 1888		40,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

Abstracts of bids received and opened November 30, 1885, for building a steam snag-boat for the improvement of the Chattahoochee River, Georgia and Alabama.

No.	Names of bidders.	Price.	Time of commencing.	Time of completion.	Where delivered.
1	M. A. Sweeney & Bro., Jeffersonville, Ind.	$8,750	Not stated........	Not stated........	Jeffersonville, Ind.
2	Charles Y. Abercrombie, Montgomery, Ala.	11,650	30 days after notification of approval of contract.	Within four months after commencing work.	Mobile, Ala.
*3	Edward J. Howard, Jeffersonville, Ind.	8,775	Not stated........	Not stated........	Jeffersonville, Ind.
†4	Rittenhouse Moore, Mobile, Ala.	13,500	....do..............	Not stated........	Not stated.
*5	William Foster and August Kling, Mobile, Ala.	11,998	30 days after notification of approval of contract.	Within four months after commencing work.	Chattahoochee, Fla.

*No seals and no plan of capstan submitted. Erasures not explained.
†No plan of capstan submitted.

NOTE.—Before opening any other bid the bidder who was present was permitted to file a supplementary paper supplying an omission as to the time of commencing and completing the work bid for. Interlineations in bid not explained.

COMMERCIAL STATISTICS.

Number of steamboats employed in the commerce of this river............	9
Valuation..	$124,500
Tonnage..	1,270
Draught, in feet...	2 to 5

During the year ending June 30, 1886, these boats carried in freight as follows:

Commercial fertilizers..........................	tons..	9,061
Iron..	do....	240
Cotton..	bales..	52,500
Grain...	bushels..	189,700
Lumber..	feet..	250,000
Merchandise...	bales..	2,560
Merchandise...	barrels..	662,400
Live stock..	head..	490
Total valuation.......................................		$8,440,928
Total valuation of freights...........................		90,620
Total valuation of passenger traffic..................		36,400
Aggregate valuation of river business.................		8,567,948
Aggregate value in 1885...............................		7,945,948

The large increase in our river's business for the present year is mainly caused by the improved condition of the river as caused by Government appropriations, thus enabling our boats to run the year through, and by connections with railroad points below to offer through rates for cotton and merchandise to and from all points east and north in competition with our local railroads, thus increasing very materially the amount of business to our boats, and enabling the merchants on the river to compete in freights with other points not so favorably located.

C. E. HOCHSTRASSER,
Vice-President Columbus Board of Trade.
E. L. WELLS,
Secretary Columbus Board of Trade.

COLUMBUS, GA., *July*, 1886.

O 7.

IMPROVEMENT OF ALABAMA RIVER, ALABAMA.

This stream is formed by the junction of the Coosa and Tallapoosa rivers, 18 miles above Montgomery, Ala., in the central portion of the State, and flows southward past the town of Selma, uniting with the Tombigbee to form the Mobile River, which empties into Mobile Bay. This river, with its principal tributary, the Coosa, now under improvement, offers a continuous line of water transportation from Rome, Ga., to the Gulf of Mexico, flowing through the coal and iron deposits of Alabama and the cotton belt.

The plan of improvement for the Alabama River, adopted in 1870, contemplates a channel 200 feet in width and 4 feet in depth at low-water from its mouth, 50 miles above Mobile, Ala., to Wetumpka, Ala., a distance of 323 miles. Before the improvement was commenced, the channel had a lowest depth of about 2 feet on some of the shoals, and was obstructed by snags and overhanging trees.

The expenditure up to June 30, 1886, of $129,714.12, has resulted in opening 20 miles of the lower river, below the cut-off, before inaccessible during low water, and rendering that part of the river below Montgomery, Ala., easy of navigation during ordinary low water.

During the past fiscal year but little work could be done, except the pulling of snags and logs washed in since the previous season over the the worst portion of the river, the appropriation being insufficient for the further extension of the work of improvement. An excellent working plant for this river is on hand, and with sufficient appropriations can be made to do efficient work. In the absence of such appropriations, this plant will decay before any adequate return has been had for the expenditure in providing it. The work done was principally in the vicinity of Gardner's Island, between Montgomery and Selma, at which point a brush dam was constructed, closing one of the chutes and concentrating the water into a new channel, offering a greater assurance of permanency.

Continued high water interfered quite seriously with operations during the past fiscal year. The work has been in charge of Assistant Engineer J. E. Turtle.

It is proposed to expend the funds remaining on hand and the appropriation asked for in the employment of the present working plant for the removal of snags and other obstructions from the channel, and in the construction and repair of contraction works upon other shoals in this river.

The value of the working plant upon this river is estimated at $19,995. When worked to its full capacity an annual expenditure of $20,000 is required; a less expenditure with the present working plant is injudicious. With a slight increase of plant about $40,000 can be profitably expended during the fiscal year ending June 30, 1888.

The original estimate of cost of this improvement is $229,741. The work of removing the annual accumulation of obstructions in the river channel, due to freshets, has been added to the work contemplated by this estimate, as well as the cost of renewing and extending works of contraction. The river has, generally, a movable bottom and caving banks. The improvement will have, with an annual expenditure for the maintenance of the work, that degree of permanence which can be given to such a stream by works of contraction.

The census of 1880 gives for the counties bordering upon this river, within the limits of the proposed improvement, a total assessed valuation of real and personal property amounting to $25,520,752, and a total taxation of $461,681.

COMMERCIAL STATISTICS.

Letters were addressed to parties presumably interested in the navigation of this river, and competent to furnish commercial statistics, but no information has been received.

Money statement.

July 1, 1885, amount available		$6,003 76
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$5,717 88	
July 1, 1886, outstanding liabilities	65 75	
		5,783 63
July 1, 1886, amount available		220 13
Amount appropriated by act approved August 5, 1886		15,000 00
Amount available for fiscal year ending June 30, 1887		15,220 13
Amount (estimated) required for completion of existing project		84,741 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		40,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

O 8.

IMPROVEMENT OF TALLAPOOSA RIVER, ALABAMA.

This river rises in the northwestern part of Georgia and flows in a southwesterly direction past the town of Tallassee to the Alabama River, a short distance below Wetumpka. It has a fine water-power at Tallassee, which has been partially utilized by mills at that point, and below this flows through a fine agricultural country.

The plan of improvement, pursuant to an examination and partial survey of this river made by an act of Congress approved June 14, 1880, contemplates obtaining a navigable channel from the mouth of the river to the foot of Tallassee Reefs, 2 miles below the town of Tallassee, a distance of 48 miles, with a least depth of 3 feet and width of 60 feet at low water. This is to be accomplished by the removal of snags, logs, &c., from the channel, cutting overhanging trees from the banks, the cutting of the prescribed channel through the rock-reefs and the removal of bars by works of contraction.

The expenditure up to June 30, 1886, of $23,441.46 has resulted in the partial improvement of the channel in the lower portion of this river, but the work has not progressed sufficiently to affect navigation.

During the past fiscal year 2,423 snags, logs, and overhanging trees were removed, clearing the river of obstructions for a distance of 12½ miles. Continued high water interfered quite seriously with operations.

The work was in charge of Assistant Engineer J. E. Turtle.

It is proposed to apply the amount on hand and the appropriation asked for to the employment of the present working plant in the removal of snags and logs from the channel and cutting overhanging trees, in continuation of the present method of improvement.

The value of the working plant upon this river is estimated at $6,950. When worked to its full capacity an annual expenditure of $15,000 is required; a less expenditure with the present working plant is injudicious. With an increase of plant about $30,000 can be profitable expended during the fiscal year ending June 30, 1888.

The original estimate of cost of this improvement is $40,125. To this must be added the cost of removing obstructions brought into the river channel by freshets since the date of the original estimate. This river, within the limits of the proposed improvement, has generally a movable bottom and caving banks, with, however, a moderate slope. The improvement will have that degree of permanence which can be given by works of contraction to rivers having such characteristics. An annual expenditure will be required for the removal of obstructions constantly accumulating in the channel and for the maintenance of the works.

The census of 1880 gives for the counties bordering upon this river within the limits of the proposed improvement a total assessed valuation of real and personal property amounting to $13,528,123 and a total taxation of $258,052.

COMMERCIAL STATISTICS.

It has been estimated that the falls at Tallassee, 2 miles above the upper limit of the proposed improvement, furnish a valuable water-power of about 6,000 horse-power, of which about one-eighth is now utilized, and that this improvement will furnish transportation for cotton and merchandise to the value of $1,700,000, and probably more, should the improvement of the river lead to a full development of the water-power at Tallassee. It is not known that any vessels have been employed in the navigation of this river during the past fiscal year.

Money statement.

July 1, 1885, amount available		$7,098 80
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$5,522 26	
July 1, 1886, outstanding liabilities	45 00	
		5,567 26
July 1, 1886, amount available		1,531 54
Amount appropriated by act approved August 5, 1886		7,500 00
Amount available for fiscal year ending June 30, 1887		9,031 54
Amount (estimated) required for completion of existing project		15,107 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

O 9.

IMPROVEMENT OF CAHABA RIVER, ALABAMA.

This river rises in the northwestern part of Alabama, flows in a southerly direction past the town of Centreville, and through the Cahaba coal and iron district, to the Alabama River at Cahaba, Ala. The principal object of its improvement is the development of the water-way for the output of the Cahaba coal and iron district. The plan of improvement adopted in 1883 contemplates a channel 60 feet in width and 3 feet in depth at low water from its mouth to the town of Centreville, a distance of 38 miles, by the removal of all obstructions from the channel, cutting through the rock-reefs, cutting overhanging trees, and removing bars by works of contraction.

The expenditure up to June 30, 1886, of $28,989.79, has resulted in the partial improvement of the river from its mouth to Centreville, adapting it to high-water navigation. This is within a distance of 21 miles of Cane Creek, which is within the Cahaba coal-fields. For this section of the river lock-and-dam navigation has been proposed.

During the past fiscal year 1,516 snags, logs, and trees were removed, clearing the river of obstructions for a distance of 19½ miles. Continued high water in the river interfered quite seriously with active operations.

The work has been in charge of Assistant Engineer J. E. Turtle.

It is proposed to apply the funds available and the appropriation asked for in the employment of the present working plant for the removal of logs and snags from the channel and in cutting overhanging trees upon the banks.

The value of the working plant upon this improvement is estimated at $6,950. When worked to its full capacity an annual expenditure of $15,000 is required; a less expenditure with the present working plant is injudicious. With an increase of plant about $30,000 can be profitably expended during the fiscal year ending June 30, 1888.

The original estimate of cost of this improvement is $195,000. The annual accumulation of obstructions in the channel must be added to the work contemplated by this estimate, the river from Centreville to its mouth having generally a movable bottom and caving banks covered with timber. The improvement will have that degree of permanence which can be given by works of contraction to a river with such characteristics of bottom and banks and having at several points a very steep slope. An annual expenditure will be required for the removal of obstructions and the maintenance of the works.

The census of 1880 gives for the counties bordering upon this river within the limits of the proposed improvement, a total assessed valuation of real and personal property amounting to $9,118,034 and a total taxation of $156,526.

COMMERCIAL STATISTICS.

It is not thought that any vessels have made use of this river during the past fiscal year. It has been estimated that the improvement of this river will furnish transportation for cotton and merchandise to the value of about $3,870,000, and that the saving to the planters adjacent to the river on their cotton crops alone will be $60,000 annually; that with slackwater navigation above Centreville to Cane Creek the main business of the river will result from the development of the immense coal, iron, and timber interests of the Cahaba Valley, but that this development will require an extension of the river improvement by a system of slackwater navigation from Centreville to Cane Creek, a distance of 21 miles.

Money statement.

July 1, 1885, amount available		$5,197 97
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$4,187 76	
July 1, 1886, outstanding liabilities	49 50	
		4,237 26
July 1, 1886, amount available		960 71
Amount appropriated by act approved August 5, 1886		7,500 00
Amount available for fiscal year ending June 30, 1887		8,460 71

Amount (estimated) required for completion of existing project	$157,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

O 10.

IMPROVEMENT OF CONECUH-ESCAMBIA RIVER, FLORIDA AND ALABAMA.

Under the name of Conecuh River, this stream rises in the southeastern part of Alabama and flows past the towns of Andalusia, Brewton, and Pollard to the Florida State line, where the name changes to Escambia River, and the stream continues southward to Pensacola Bay. It flows through a very extensive lumber district of long-leaf yellow pine, contributing largely to the export trade of Pensacola.

The plan of improvement for this river, adopted pursuant to partial examinations and surveys made in 1878 and 1879, contemplates the removal of snags and sunken logs and other obstructions from the channel, closing cut-offs, and cutting through the rock shoals from the mouth of the river in Pensacola Bay to Indian Creek, a distance of 273 miles, for the purpose of facilitating the movement of logs and rafts down the river, affording at the same time facilities for steamboat navigation.

Up to June 30, 1886, the expenditure of $38,953.64 has resulted in dredging a channel through the bar at the mouth of the river, and in the removal of obstructions to navigation, so that at the present time the river is navigable at ordinary stages of water for steamboats drawing 5½ feet of water from Ferry Pass to Skinner's Landing, a distance of 17 miles, and for boats drawing 3 feet to the Alabama State line. Above this point, the channel has been improved sufficiently to give increased facilities to the commerce of the river.

During the past fiscal year, 10,943 logs, snags, and overhanging trees, and 105½ cubic yards of rock were removed, clearing the river of obstructions for a distance of 140 miles. This is a work which will require constant attention and continued appropriations, fresh obstructions being brought in annually by the freshets of winter and spring.

It is proposed to apply the funds remaining on hand and the appropriation asked for to the continuation of the work of improvement by the removal of logs, snags, and other obstructions from the channel, closing cut-offs, and cutting through rock shoals. The work has been in charge of Assistant Engineer Hiram Haines.

The value of the working plant upon this improvement is estimated at $2,755. When worked to its full capacity, an annual expenditure of $15,000 is required; a less expenditure with the present working plant is injudicious. With an increase of plant, about $30,000 can be profitably expended during the fiscal year ending June 30, 1888.

The original estimate of cost of this improvement is $87,430. The river has, generally, a movable bottom and caving banks, bordered by a thick growth of timber, with only an occasional rock shoal. The annual accumulation of obstructions, due to freshets, has been added to the work contemplated by the original estimate. The improvement will have, with an annual expenditure for maintenance, that degree of permanence which can be given to such a river by works of this character.

The census of 1880 gives, for the counties bordering upon this river, a total assessed valuation of real and personal property amounting to $5,649,647, and a total taxation of $118,767.

Money statement.

July 1, 1885, amount available		$9,296 23
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$8,195 87	
July 1, 1886, outstanding liabilities	34 50	
		8,230 37
July 1, 1886, amount available		1,065 86
Amount appropriated by act approved August 5, 1886		12,000 00
Amount available for fiscal year ending June 30, 1887		13,065 86
Amount (estimated) required for completion of existing project		35,376 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		30,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

During the fiscal year ending June 30, 1886, this stream has carried down 4,140,000 cubic feet of sawn timber, 1,008,000 cubic feet of hewn timber, 90,000 saw logs, and 3,500 cedar logs.

During the season of high water occasional trips were made by steamboats between Pensacola, Bluff Springs, and Andalusia, transporting merchandise and agricultural products.

O II.

IMPROVEMENT OF CHOCTAWHATCHEE RIVER, FLORIDA AND ALABAMA.

This river rises in Southeastern Alabama, and flows in a southerly and southwesterly direction past the towns of Newton, Geneva, and Caryville (the crossing of the Pensacola and Atlantic Railroad), emptying into the Choctawhatchee Bay, whence Santa Rosa Sound connects it with Pensacola Harbor. The river flows through a rich agricultural country, in a region which contributes, by means of this river and Santa Rosa Sound, a large proportion of the lumber transported from Pensacola. The States of Alabama and Florida have appropriated $40,000 heretofore for the improvement of the river from Geneva to its mouth. The present plan of improvement, made pursuant to an examination, under authority of an act of Congress approved in 1871, and a subsequent examination under an act approved March 3, 1879, was adopted in 1872 and modified in 1880, and contemplates the improvement of the river from its mouth to Newton, a distance of 252 miles, so as to obtain a low-water navigable channel.

The expenditure of $71,645.95 up to June 30, 1886, has resulted in giving 4½ feet of water in the channel, except during low water, as far as Jones's Old Ferry, 27 miles above Geneva, and 2 feet of water in the channel as far as Pates Creek at a medium stage of water. During high water 4 feet can be carried to this point.

During the past fiscal year 8,787 snags, logs, and overhanging trees were removed, clearing the river of obstructions for a distance of 32 miles. The work has been in charge of Assistant Engineer W. A. Gould.

It is proposed to apply the funds remaining on hand and the appropriation asked for to the further improvement of this river by the removal of logs and snags from the channel and cutting through rock shoals and removing bars by works of contraction.

The value of the working plant upon this improvement is estimated at $2,410. When worked to its full capacity an annual expenditure of $15,000 is required; a less expenditure with the present working plant is injudicious. With an increase of plant about $30,000 can be profitably expended during the fiscal year ending June 30, 1888.

The original estimate of cost of this improvement as amended in 1880 is $122,832. The limited appropriations have compelled slow progress of the work, and the annual accumulation of obstructions, due to freshets in the river, have been added to the work contemplated by the estimate. The improvement, with an annual expenditure for maintenance and repair, will have that degree of permanence which can be given to a river with a movable bottom and caving banks.

The census of 1880 shows that in the several counties which border upon this river the total assessed valuation of property, real and personal, is $1,446,636; and the total taxation, $24,278.

Money statement.

July 1, 1885, amount available		$10,094 45
July 1, 1886, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1885	$9,740 40	
July 1, 1886, outstanding liabilities	45 00	
		9,785 40
July 1, 1886, amount available		309 05
Amount appropriated by act approved August 5, 1886		15,000 00
Amount available for fiscal year ending June 30, 1887		25,094 45
Amount (estimated) required for completion of existing project		35,832 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		30,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

NEWTON, ALA., *July* 21, 1886.

DEAR SIR: Your favor of the 9th instant received and contents noted. We would most respectfully state that we believe your commercial statistics for 1884 are approximately correct, and we are sorry that we cannot add anything thereto, being wholly unacquainted with the lower river.

There is some difficulty in stating actual figures, but will endeavor to state a few facts concerning Choctawhatchee River.

Believing the trade would justify, and the river carry, we had a first-class steamboat built (the M. H. Smith) of 200 tons capacity, which made two trips to Pates Creek with cargo both ways, and we were in high hopes of permanent navigation to that point. After trial it was found impracticable on account of obstructions, *but in no case scarcity of water.*

* * * * * * *

There is little doubt that if the Smith could have run there would have been a good trade the past season.

There is now only one little boat on the upper river, and her capacity is so small that the merchants cannot depend on her, which necessitates the wagoning of goods, as of old, 30, 40, and 50 miles.

While we do not wish to misrepresent or attach undue importance, we candidly believe there is not a river in your district that would give as great returns for the outlay as the Choctawhatchee. We would respectfully refer you to the maps of Alabama and Florida, which will show the extent of country adjacent, and which is without transportation except on its waters.

* * * * * * *

These statements are only intended to represent the present and prospective situation of trade and country in proximity to the river between Caryville, Fla., and Newton, Ala., inclusive.

* * * * * * *

Yours, very respectfully,

J. R. KELLY,
President Choctawhatchee Transportation Company.

R. L. HOXIE,
Captain, United States Engineers.

Towns in proximity to the river, and would ship on it.	Area that would trade to the river, navigation being established.	Merchants at present.	People buying supplies and shipping in this territory at present.	Approximate value of goods, groceries, cotton, wool, fertilizers, &c., sold annually.	Expected increase in sale of goods, &c., on basis of navigable outlet on river.	Expected increase in fertility of soil by increased application of commercial fertilizers.
	Sq. miles.	*No.*	*No.*			
Newton*	350	6	5,000	$450,000	Tenfold	Threefold.
Ozark*	200	10	6,000	500,000	Twofold	Twofold.
Echo*	250	3	2,500	225,000	....do	Do.
Headland*	350	6	5,000	450,000		
Dothan*	350	3	2,000	125,000	Twofold	Twofold.
Skipperville*	200	5	8,000	250,000		
Haw Ridge*	300	2	1,000	150,000		
Clintonville*	200	1	1,000	100,000	Twofold	
Elba*	550	10	7,000	600,000	One and one-half	Twofold.
Daleville*	200	1	1,000	150,000	Tenfold	Fivefold.
Geneva†	550	12	1,000	900,000	Fivefold	Twofold.
Ennola‡	200	2	5,000	200,000	....do	Threefold.
Cerro Gordo§	600	1	1,000	200,000		
Caryville‖	600	2	8,000	2,500,000		
Total	4,900	64	52,500	6,800,000		

* Agricultural district.
† Timber and agricultural district.
‡ Turpentine and rosin district.
§ Logging district.
‖ Lumber district.

O 12.

IMPROVEMENT OF LA GRANGE BAYOU, FLORIDA.

The La Grange Bayou extends about 2 miles in a northeasterly direction from the north side and near the head of Choctawhatchee Bay, and into it flows Cedar Creek, a deep stream, from 90 to 160 feet wide, on which is situated the town of Freeport, 1½ miles above the bayou.

The plan of improvement adopted was made pursuant to an examination of this bayou in 1881, under an act of Congress approved March 3, 1881, and contemplates the deepening of the channel through the bayou so as to admit the passage of vessels drawing 4½ feet at mean low water, the work to be done by dredging.

Up to June 30, 1886, there has been expended on this work the sum of $2,000, allotted from the appropriation of $20,000 made by an act approved August 2, 1882, for the improvement of the Choctawhatchee River, Florida, the two improvements being closely related. The result has been to secure a channel 5 feet in depth at mean low water.

During the past fiscal year no work has been done, no appropriation being available. It is proposed to expend the appropriation asked for in widening the existing channel and in removing the remaining obstructions.

There is no working plant upon this improvement. It is thought that the amount asked for, $5,000, will be sufficient to afford proper facilities to the commerce of this bayou.

The original estimate of cost of this improvement is $19,994.30. It is thought that the improvement will be reasonably permanent.

The census of 1880 gives for the counties bordering upon La Grange Bayou within the limits of this improvement a total assessed valuation of real and personal property amounting to $244,506, and a total taxation of $3,362.

Money statement.

Amount appropriated by act approved August 5, 1886	$2,000 00
Amount available for fiscal year ending June 30, 1887	2,000 00
Amount (estimated) required for completion of existing project	3,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	3,000 00
Submitted in compliance with the requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

A. J. Gillis and other merchants and residents of Freeport, Fla., state that the commerce of La Grange Bayou annually, including lumber, timber, produce, and various merchandize, approximates $100,000.

That in this commerce and that of other tributaries of the Choctawhatchee Bay twenty schooners, with an aggregate of 550 tons, together with numerous smaller craft, and a few steam vessels, are engaged.

O 13.

IMPROVEMENT OF PENSACOLA HARBOR, FLORIDA.

Pensacola Harbor, on the coast of Florida, is a deep-water harbor on the Gulf of Mexico, within which is an extensive naval establishment of the United States, and from which, during the last fiscal year, there cleared 525 steamships and sailing vessels, aggregating 325,393 tons.

The improvement of this harbor was commenced in 1878, by the removal of certain wrecks forming obstructions to navigation. In 1879 a survey was made for the purpose of ascertaining the extent and probable cause of the shoaling of the main ship-channel at a point known as the "Inner Bar," and pursuant to this survey, which was referred to the Board of Engineers on Fortifications and Harbor Improvements, a plan of improvement was adopted which contemplates the temporary relief of navigation by dredging a channel across the inner bar, and the preservation of the shore-line at the site of Fort McRee by the construction of jetties and shore protection, for the purpose of protecting the site for defensive works, and preventing further changes in the tidal currents, the channel to be dredged to a depth of 24 feet with a width of not less than 300 feet.

The expenditure up to the present time of $192,223.99 has resulted, as to the channel, in obtaining a depth of 24 feet at mean low water over the inner bar, with a width of 120 feet. This increased width and depth were not maintained by the tides, and the channel has required redredging. On June 30, 1886, a least depth of 23 feet existed. The work of shore protection has resulted in arresting the process of abrasion and advancing the shore-line about 250 feet, while the 12, 18, and 24 foot-curves of the western channel fronting this shore-line have also advanced. North of the work at Fort McRee the shore-line has not materially changed, the point being held by the works. To the west of this point, towards the mainland, the shifting sand-banks which mark the entrance to the lagoon have moved southward, and are to a great extent covered by the débris of the fort which has been washed around. This work may be regarded as permanent when the jetties are protected by suitable coping and slope protection. It would probably require after that only very slight annual repairs. The channel must be dredged continuously during favorable weather, at a cost which was estimated last year at $50,000, but which it is now thought will be considerably less.

During the past fiscal year active operations were suspended upon this improvement, owing to the near exhaustion of the appropriation, it being necessary to retain sufficient funds to keep the works in repair. Repairs were made upon the shore protection during the months of October and November, 1885, consisting of the renewal of the outer bulkhead and restoring mattress work and ballasting; 55,354.71 cubic yards of material were removed from the dredged channel by the suction-dredge G. W. R. Bayley. The jetties were subjected to the action of storms during the winter and more or less damaged by them. A severe gale occurred on May 18, 1886, destroying the wharf, and on June 24, 1886, and June 29, 1886, causing further injury to the outer ends of jetty A and the shore protection. The work has been in charge of Assistant Engineer Hiram Haines.

It is proposed to apply the funds remaining on hand, and the appropriation asked for, to the completion of the works of shore protection at the site of Fort McRee in such manner as will make them reasonably permanent, and to the continuance of the work of dredging the inner bar for the relief of navigation. Up to this time the works of shore protection, having been of a tentative character, are perishable and must be promptly strengthened, or they will be destroyed, with the resulting loss of every advantage gained hitherto. These works are exposed to the action of violent storms from the Gulf, the waves which break upon the shore at this point having great destructive power.

The value of the working plant upon this improvement is estimated at $2,250. By the use of this plant, the existing works of shore protection may be expeditiously completed in a permanent manner, leaving their further extension a question for the future. It seems to be a matter of great importance to secure, at once, in this manner, what has already been gained. No working plant is available for the work of dredging in the harbor, which must be done under contract or by the hire of a suitable plant.

Forty thousand cubic yards of sand will have to be removed to complete the existing project for the temporary relief of navigation, including the material which has silted into the dredged channel. It is desirable, if only in the interest of economy, to complete this in a single working season.

The ultimate cost of this work is not estimated in the original project, which assumes that it will exceed $150,000. It is now estimated that $40,000 will be required for completion, making the total cost of the work $235,000. At the date of the original project the proposed channel required the removal of 36,000 cubic yards of sand. At this date, 142,000 cubic yards have been removed, and 40,000 cubic yards remain to be excavated. The cost of maintenance depends upon the rate at which the dredged channel will continue to fill, and the cost of maintaining the works of shore protection in their exposed position at Fort McRee. This cost enters largely into the expenditures up to the present time, not only for redredging the channel, but for restoring the shore protection. The rate of silting up in the channel appears to have diminished since the shore-line has been held by the works at Fort McRee.

Money statement.

July 1, 1885, amount available		$31,800 29
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$29,024 28	
July 1, 1886, outstanding liabilities	330 00	
		29,354 28
July 1, 1886, amount available		2,446 01
Amount appropriated by act approved August 5, 1886		20,000 00
Amount available for fiscal year ending June 20, 1887		22,446 01
Amount (estimated) required for completion of existing project		20,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

The export trade of this harbor is principally carried on in vessels of large capacity and consequently deep draught, the principal article of export being a bulky material, lumber and timber.

The capacity of these vessels sometimes exceeds 1,800 tons; for this reason a considerable depth of water over the bar is desirable.

During the past fiscal year there were entered at the port of Pensacola 516 vessels, whose aggregate tonnage was 319,407 tons. There were cleared 525 vessels, whose aggregate tonnage was 325,393 tons. In the traffic of Pensacola Harbor 112 steamers and sailing vessels were employed.

There were exported 8,825 bales of cotton, and 107,701,000 feet, B. M., of lumber and timber.

Value of imports and exports.

Direction.	1886.	1885.	Remarks.
Value of exports to foreign ports	$2,184,066	$1,967,275	There has been a large increase in coastwise imports, especially of fertilizers and guanos.
Value of exports to coastwise ports	827,890	806,635	
Total value of exports	3,011,958	2,773,910	
Value of imports from foreign ports	159,237	9,912	
Value of imports from coastwise ports	(*)	536,682	
Total value of imports	159,237	546,594	
Total value of imports and exports	3,171,195	3,320,504	

* No record.

Custom-house receipts.

Description.	1886.	1885.
Duties on imports	$5, 369 41	$9, 911 [illegible]
Tonnage tax	13, 595 46	8, 346 15
Marine hospital tax	8 84	538 [illegible]
Fines, penalties, and forfeitures	....	202 73
Inspection of steam vessels	190 00	116 [illegible]
Immigrant fund	16 00	19 50
Official fees	3, 117 59	2, 748 [illegible]
Miscellaneous	....	950 [illegible]
Total	22, 292 30	22, 835 [illegible]

APPENDIX P.

IMPROVEMENT OF THE HARBOR OF MOBILE; OF WARRIOR, TOMBIGBEE, AND BLACK WARRIOR RIVERS, ALABAMA, AND OF CERTAIN RIVERS IN MISSISSIPPI—IMPROVEMENT OF CHANNEL TO BILOXI BAY, AND OF HORN ISLAND PASS.

REPORT OF MAJOR A. N. DAMRELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Mobile Harbor, Alabama.
2.
   - Warrior River, Alabama.
   - Tombigbee River, from Fulton to Vienna.
   - Tombigbee River, below Vienna.
3. Black Warrior River, from Tuscaloosa to Daniel's Creek, Alabama.
4. Old Town Creek, Mississippi.
5. Noxubee River, Mississippi.
6. Pascagoula River, Mississippi.
7. Harbor at Biloxi Bay, Mississippi.
8. Horn Island Pass, Mississippi.
9. Pearl River, Mississippi, below Jackson.
10. Pearl River, Mississippi, from Jackson to Carthage.
11. Pearl River, Mississippi, between Edinburg and Carthage.

EXAMINATIONS AND SURVEYS.

12. Pascagoula River, Mississippi, from the mills at Moss Point down to the anchorage in the bay, with a view to securing a uniform depth of 12 feet of water.
13. Wacissa River, Florida.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., August 6, 1886.

SIR: I have the honor to forward herewith annual reports for fiscal year ending June 30, 1886, for the works of improvement under my charge.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

P 1.

IMPROVEMENT OF THE HARBOR AT MOBILE, ALABAMA.

The improvement of the channel of the harbor at Mobile, Ala., was begun by the General Government in 1827, the depth of water then being 5½ feet through Choctaw Pass and 8 feet on Dog River Bar.

The appropriations from 1827 to 1857 were as follows:

By act of Congress May 20, 1826	$10,000 00
By act of Congress March 2, 1829	20,000 00
By act of Congress June 23, 1834	10,000 00
By act of Congress March 3, 1835	17,997 60
By act of Congress March 3, 1837	50,000 00
By act of Congress July 7, 1838	50,000 00
By act of Congress August 30, 1852	50,000 00
	$207,997 60
By act of Congress March 3, 1857, relief claim	20,833 08
Total	$228,830 68

The result obtained was a channel 10 feet deep and 200 feet wide through the pass and the same depth with an unknown width over the bar. In 1860 the channel through the pass was found to have shoaled to 7½ feet, the depth of water on the bar remaining the same.

No further improvement was attempted until 1870.

From 1870 to 1875 the following amounts were appropriated for the purpose of obtaining a depth of 13 feet:

By act of Congress July 11, 1870	$50,000
By act of Congress March 3, 1871	50,000
By act of Congress June 10, 1872	75,000
By act of Congress March 3, 1873	100,000
By act of Congress June 23, 1874	100,000
By act of Congress March 3, 1875	26,000
Total	401,000

This amount was expended in dredging a channel 13 feet deep and 300 feet wide from the mouth of the Mobile River through "Choctaw Pass," and in deepening and extending that through "Dog River Bar" to the 13-foot curve in the bay. The work was completed in September, 1876, and the channel remained practically as it was dredged until the commencement of the present project, February 19, 1881.

In 1878 a survey was directed to be made in order to determine whether the existing channel could be improved to a depth of 22 feet, and for this purpose Congress, by act of June 18, 1878, appropriated the sum of $10,000.

The survey was made and a report was submitted to the Chief of Engineers suggesting several plans of improvement. In March, 1880, it was finally decided to continue the former improvement by dredging to a depth of 17 feet with a uniform width of 200 feet from the 17 foot curve in Mobile River to the curve of the same depth in the lower bay, the estimated cost being $820,000.

From 1878 to June 30, 1885, the following amounts have been appropriated:

By act of Congress June 18, 1878 (survey)	$10,000
By act of Congress March 3, 1879	100,000
By act of Congress June 14, 1880	125,000
By act of Congress March 3, 1881	100,000
By act of Congress August 2, 1882	125,000
By act of Congress July 5, 1884	200,000
Total	660,000

Under authority of the act of March 3, 1879, bids for dredging were called for and opened May 20, 1880, but all, being considered too high, were rejected and the work readvertised. In the mean time, June 14, 1880, Congress appropriated an additional amount of $125,000, and the contract for the total amount of $225,000 was awarded to George C. Fobes & Co., of Baltimore, Md., at 12.3 cents per cubic yard, the lowest bid under the previous call being 24.9 cents.

The contractors commenced work February 19, 1881, and completed their contract November 9, 1882, removing, in accordance with the terms of the contract, 1,610,804 cubic yards. The sum of $100,000 was further appropriated March 3, 1881, and the contract awarded to G. L. Long, of Mobile, Ala., at 11.7 cents per cubic yard. He commenced work on March 21, 1882, and finished January 24, 1884, the contractor having removed 724,730 cubic yards.

On August 2, 1882, the sum of $125,000 was appropriated, and the contract awarded to R. Moore, of Mobile, Ala., at 12.3 cents per cubic yard. The work was begun January 24, 1883, and finished February 9, 1884, the contractor having removed 888,093 cubic yards.

Congress, by act of July 5, 1884, appropriated the sum of $200,000 to continue the improvement, and the contract was awarded to Mr. Tobias Burke, of Mobile, Ala., at 9 cents per cubic yard. The work was commenced September 19, 1884, and finished June 15, 1886, 1,920,438 cubic yards being removed under this contract.

No further appropriation having been made, and the funds available exhausted, work on the improvement was suspended June 15, 1886.

TOTAL AMOUNT OF MATERIAL REMOVED FROM THE CHANNEL UNDER PRESENT PROJECT FROM FEBRUARY 19, 1881, TO JUNE 15, 1886.

	Cubic yards.
Under contract with George C. Fobes & Co	1,610,804
Under contract with G. L. Long	724,730
Under contract with R. Moore	888,093
Under contract with Tobias Burke	1,920,438
Total	5,144,065

The progress of the improvement of the channel from Mobile to the anchorage in the lower bay during the fiscal year ending June 30, 1886, was as follows:

First. Total number of cubic yards of material removed, 623,597.

Second. Cut No. 5 was dredged from a point 2,266 feet south of cluster of piles No. 35 to Cluster No. 38, a distance of 6,074 feet, and from a point 1,112 feet south of Cluster No. 40 to 600 feet south of Cluster No. 50, or to the curve of 17-foot depth in the lower bay, a distance of 27,318 feet, thus completing this cut from the elbow at the Fowl River Light to the southern entrance, a distance of 10 miles.

Third. Cut No. 4 was extended south from a point 1,250 feet below the upper gap of obstructions to a point 5,287 feet below the lower gap of obstructions, a distance of 9,753 feet, also from Cluster No. 30 to Cluster No. 31, on the Fowl River Reefs, a distance of 1,847 feet, making a total length of 11,600 feet = $2\frac{18}{100}$ miles.

Fourth. Several portions of the channel were redredged, as follows:

Cut No. 2, Clusters 30, 31, Fowl River Reefs, a distance of 1,847 feet, and 15,268 cubic yard removed.

Cut No. 3, on Dog River Bar, between Pile No. 10 and Cluster No. 7, a distance of 6,212 feet, and 46,590 cubic yards removed.

Cut No. 5, from Cluster No. 38 to 1,112 feet south of Cluster No. 40, a distance of 6,568 feet, and 60,739 cubic yards removed.

In the mouth of Mobile River Cuts No. 1, 2, 3, and 4 were redredged, and the aggregate distance of the four cuts equaled 4,470 feet, and number of cubic yards of material removed was 24,959.

The total length of the cuts redredged 19,097 feet=3.617 miles; the total number of cubic yards of material removed 146,656.

From surveys made during the years 1885 and 1886 the condition of the channel was found to be as follows:

First. Commencing at the 18-foot curve, in Mobile River, the course of the channel bears south 40° 59′ east (true course) to the second cluster of piles, located near the end of the Pinto Island Spit; at this cluster the direction is deflected 15° 27′ to the left, and bears south 56° 26′ east to the upper gap of the obstructions. This portion of the channel is what is known as "Choctaw Pass," and is $\frac{72}{100}$ of a mile in length, has a central depth varying from 18 feet to 23 feet, with a width between the top of the slopes of 200 feet. It was dredged 19 feet deep and 145 feet wide. The character of the material is a mixture of sand and mud, with a top layer of compact sand of 2½ feet in thickness.

In the fall of 1882 four cuts were dredged, with total width of 145 feet and depth of 19 to 20 feet, through this portion of the channel, and every subsequent examination showed an increased width and depth until the spring of 1886, when one of the greatest freshets known in the history of the State occurred in the rivers above. During May, 1886, an examination of the sand-bars in front of the city and of the upper portion of the channel was made, and the depth of water on the bars was found to have increased, giving a continuous 17½-foot channel along the entire city front, while at the mouth of the river the depth was diminished to 15½ feet on the crest and an average length of 1,112 feet.

This was removed during May and June of the present fiscal year, restoring the channel to the depth and width obtained by dredging in 1882.

Second. At the upper gap of the obstructions an angle of 34° 6′ to the right is made, the channel bearing south 22° 20′ east (true course) to a cluster of piles (No. 2) a distance of 993 feet. This portion was dredged during 1881 and 1882 to a width of 245 feet and a depth of 18 to 19 feet. An examination during February, 1886, shows a width between top of slopes of 300 feet and a central depth of 20 to 21 feet. The material is a mixture of sand and mud in about equal proportions and easily removed.

Third. At Cluster No. 2 the course of the channel is further deflected to the right 25° 58′, and bears south 3° 36′ west, to the lower gap in the obstructions, a distance of 4,616 feet=$\frac{87}{100}$ of a mile.

This portion was dredged to a width of 105 feet and depth of 18 to 19 feet in 1881 and 1882, and prior to the removal of Cut No. 4, during April, 1886, had a width between top of slopes of 150 feet. Cut No. 4 increases it to 190 feet, with a bottom width of 130 feet, and 18 to 19 feet depth. The nature of material still as above.

Fourth. At the lower gap the direction is changed 11° 24′ to the right, bearing south 15¼° west to cluster of piles (No. 5) at the north end of the elbow, on Dog River Bar, a distance of 1.79 miles. From the lower gap to 1.2 miles south, Cut No. 4 was removed during April and May of 1886, giving a top width of 180 feet and central depth of 18 to 19 feet, and for the remaining $\frac{77}{100}$ of a mile the top width is 140 feet and central depth of 17½ to 19 feet, and was dredged prior to 1883. The material is a mixture of sand and mud, the proportion of sand gradually getting less, until about a mile south of the lower gap it is practically free of it.

Fifth. At Cluster No. 5 the direction changes 10° 14′ to the left, bearing south 5° west to Cluster No. 6, a distance of $\frac{26}{100}$ of a mile, and forms what is known as the "Dog River Elbow."

The experimental cut of 100 feet width, 300 feet length, and 22 feet depth, recommended by the Board of Engineers in their report of February 28, 1880 (page 1065, Part II, Report of the Chief of Engineers, 1880), is located in this elbow, and was dredged as recommended in September, 1882. It was examined in February, 1884; then had a minimum central depth of 20 feet, with a depth of 17 feet throughout a width of 125 feet. In May, 1885, the central depth was from 18½ to 19½ feet, with a depth of 17 feet for 125 feet in width. In January, 1886, the central depth was 18½ to 19 feet and 17 feet for 110 feet width, and 165 feet between top of slopes. The material is a stiff blue mud, comparatively free from sand or sediment.

Sixth. At Cluster No. 6 the direction again deflected to the left 10° 17′, bearing south 5¼ degrees east to Cluster No. 31, a distance of 12.63 miles. The nature of the material from Cluster No. 6 for about 5½ miles is stiff blue mud then for a half of a mile, or between Clusters No. 11 and 12, the stiff mud substratum is covered by a layer of sand from 0 to 2½ feet in thickness; from Cluster No. 12 to No. 20, about 4 miles, the material is entirely free of sand. At Cluster No. 20 commences the reefs of Fowl River, formed of rotten oyster-shells in ridges, and extends to cluster No. 29, about 4½ miles. From Cluster No. 29 to No. 31 the material is about the same as above the reefs. From Cluster No. 6 to No. 30, a distance of 12.28 miles, three cuts have been removed, 17 to 18 feet deep and 105 feet wide. The distance between the top of the slopes is now about 140 feet, with central depth of 17½ to 18½ feet.

From Cluster No. 30 to No. 31, a distance of $\frac{35}{100}$ of a mile, Cut No. 2 was redredged during December, 1885, and Cut No. 4 removed during January, 1886, for the purpose of giving deep-draught vessels a passing point. The top width is about 200 feet, with a bottom width of 170 feet, 18 feet deep.

Seventh. From Cluster No. 31 the course of the channel is deflected 12° 41′ to the right, bearing south 7½° west (true course) a distance of 10 miles to the curve of 17 feet in depth in the lower bay. Cluster No. 31 is at what is known as the "Fowl River Bend." This portion of the channel is so located that the extreme orthern point of the curve of 22 feet may be reached without further change in direction, with Sand Island Light in range of central line.

Five cuts have been dredged throughout this portion, and it has now a central depth of 17½ to 18½ feet, with a top width of 200 feet. The nature of the material from Cluster No. 31 is a blue mud, gradually becoming soft to Cluster No. 45, about 7¼ miles, where it offers but little resistance to vessels of 1-foot greater draught than depth of water in channel. The natural slope being very flat, and lateral currents, according to direction of the wind, being at times very strong, considerable shoaling has taken place in this portion, and will continue to do so until a sufficient width is obtained.

Tabular statement of condition of the improvement, June 30, 1886.

Locality.	Dredged, 1881-1886.			Examination, 1885-1886.	
	Length.	Width.	Depth.	Minimum top width.	Minimum central depth.
	Miles.	*Feet.*	*Feet.*		
Initial point in Mobile River to upper gap of obstructions..	.72	145	19.20	200	20.23
Upper gap of obstructions to Cluster No. 2, between obstructions	.19	245	18.19	300	20.21
Cluster No. 2 to lower gap of obstructions	.87	153	18.19	190	19.20
Lower gap of obstructions to 140 feet south of Cluster No. 4.	1.02	145	18.19	180	18.19
One hundred and forty feet south of Cluster No. 4 to Cluster No. 30 (near Fowl River Light)	13.30	105	18.19	140	17½.18½
Cluster No. 30 to 600 feet south of Cluster No. 50, or south entrance	10.35	185	18.19	200	17½ 18½
Total length of channel	26.45	....	....	....	....

From a careful examination and cross-sections of the dredged channel made during the year ending June 30, 1886, the amount of material estimated to be removed in order to complete the improvement of the channel of Mobile Bay, as at present projected, viz, 200 feet width and 17 feet depth at mean low tide, is 1,586,847 cubic yards, and allowing one foot for back-filling the amount is 1,991,049 cubic yards, distributed as follows:

Locality.	Length and width to be dredged.		Depth=17 feet.	Depth 18 feet.
	Length.	Width.		
	Miles.	*Feet.*	*Cu. yds.*	*Cu. yds.*
From the 18-foot curve in Mobile River to the gap in the upper obstructions	.72	100	74,981	96,812
From gap in upper obstructions to Cluster No. 2	.17	100	16,329	20,744
From Cluster No. 2 to gap in lower obstructions	.87	60	29,643	41,631
From gap in lower obstructions to 140 feet south of Cluster No. 4	.85	40	33,487	41,401
From 140 feet south of Cluster No. 4 to Cluster No. 30 on Fowl River Reefs	13.32	75	1,176,698	1,424,844
From Cluster No. 30, on Fowl River Reefs, to Cluster No. 31, at Fowl River Elbow	.35	40	16,459	20,377
From Cluster No. 31, at Fowl River Elbow, to 600 feet south of Cluster No. 50, at the curve of 18 feet in lower bay	9.65	30	239,250	344,900
Total	25.93	....	1,580,847	1,991,049

The condition of the channel previous to the commencement of the present project was such that no vessel of greater draught than 12 feet could come to the city, but all such anchored in the lower bay, a distance of 28½ miles, and the cargoes were lightered or rafted to and from the city at a great expense and frequently at considerable loss of cargo and time.

The channel of 17 feet depth with a width of 175 feet was opened in October, 1882, and during the business season of 1882 and 1883 all vessels entering the bay came up to the wharves of the port and there discharged cargoes or ballast, then reloaded with full cargoes, or to a depth of 16½ feet, and in some cases to 17 feet and 17 ½feet, but owing to the vessels getting out on the slopes of the channel, thereby pressing material into the dredged channel and also causing delay to other vessels, it was deemed best to limit the draught to 16 feet until the channel was widened; the average draught therefore during 1883, 1884, and 1885, was 15½ feet. The width being increased during the fiscal year ending June 30, 1886, the draught of all vessels partially loaded at the wharves was between 15½ feet and 17 feet, the average being 16 feet, and in all cases passing through the channel without delay.

The depth of 17 feet at mean low tide was practically demonstrated on January 21, 1886, by the safe and quiet passage down the dredged channel of the British steamship Wandle. The draught of the vessel at anchor was 16.3 feet, the reading of the tide-gauges called for 15.8 feet in the channel, and the vessel with a full cargo of 4,137 bales of cotton (the largest cargo of cotton ever loaded at the wharves) passed down without any delay of any kind. Again, on May 29, 1886, the British bark Priscilla, partially loaded with cotton, drawing full 17 feet at anchor, passed down on an ebb tide, and when about half-way down the tide gauges read 1.1 foot below 17 feet.

During the winter of 1885–'86 a careful survey of Mobile River from the head of Spanish River to the gap in the upper obstructions was made, for the purpose of establishing wharf-lines on both east and west sides of the river. The improvement so far as it has progressed has given very general satisfaction. The amount available during the fiscal year ending June 30, 1887, will be expended in completing Cut No. 4, which will give a channel of 17 feet depth and minimum width at mean low tide of 186 feet, from the wharves of the port to the lower anchorage; also, in dredging Cut No. 5, from the 17-foot curve in Mobile River as far south as the funds at hand will permit.

The total amount that has been expended by the General Government toward increasing the depth of the channel of Mobile Harbor from 12 feet to 17 feet at mean low tide is $660,000, and the total amount since 1827 expended is $1,289,830.38, resulting in a gain of depth of 11½ feet, viz, from 5½ feet original depth in Choctaw Pass to a depth of 17 feet.

The immediate benefits to be derived from the improvement is the saving of lighterage and towage of cargoes of all vessels of draught exceeding 12 feet to and from the city a distance of 28½ miles; also, the far greater security and facility in discharging and loading either in part or fully the cargoes at the wharves of the city of Mobile.

The improvement is located in the collection district of Mobile, Ala. Mobile is the nearest port of entry and is situated at the northern entrance of the dredged channel 26½ miles from the southern entrance to the same, and 36 miles from the outer bar buoy in the Gulf of Mexico.

Money statement.

July 1, 1885, amount available	$75,840 61
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	74,927 83
July 1, 1886, amount available	912 78
Amount appropriated by act approved August 5, 1886	90,000 00
Amount available for fiscal year ending June 30, 1887	90,912 78
Amount (estimated) required for completion of existing project	80,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	80,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The following statistical statement for the years 1885-'86 was furnished by the collector of customs of this port:

Description.	Entrances.						Clearances.					
	June 30, 1886.			June 30, 1885.			June 30, 1886.			June 30, 1885.		
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
Foreign	109	75,003	1,468	124	73,713	1,458	121	83,947	1,670	136	87,466	1,744
Coastwise	54	24,509	507	37	11,128	241	45	16,316	348	45	8,187	371
American	34	8,172	252	47	17,369	330	46	12,571	353	38	19,068	171
Total	197	107,684	2,227	208	102,210	2,029	212	112,334	2,371	219	114,721	2,286

Imports and exports.

Description.	1886.	1885.
Duties on imports	$18,814 73	$7,513 97
Tonnage dues	3,912 84	3,438 36
Hospital collections	786 60	1,470 50
Miscellaneous	4,273 77	968 75
Total collections	27,787 94	13,391 58
Exports to foreign ports	2,834,054 00	3,015,082 00
Imports of foreign goods	69,483 00	129,046 00

Mobile Cotton Exchange statistics.

Articles.		1885-'86.	1884-'85.	1883-'84.
Cotton receipts:				
Via Alabama River	bales	43,101	40,863	29,759
Via Tombigee River	do	62,228	47,880	35,224
Via Warrior River	do	10,452	5,833	5,864
Via Mobile and Ohio Railroad	do	81,359	70,664	114,513
Via Louisville and Nashville Railroad	do	56,080	65,142	68,716
Coastwise via Pensacola, Fla	do	10,427	10,558	6,835
Total receipts		263,647	240,399	260,911
Coffee importations	sacks	24,330	27,878	19,869
Naval stores:				
Rosin	barrels	173,880	163,487	228,015
Turpentine	do	38,851	37,487	43,228
Tar	do	550	....	450
Pitch	do	....	....	2,000
Salt importations:				
Imported from Liverpool direct	sacks	19,988	....	29,597
Imported from Liverpool indirect	do	....	....	1,606
Imported from Vermillion Bay, Louisiana	do	....	....	....

Mobile Produce Exchange statistics.

Articles.		1886.	1885.	1884.	1881.
Fish and oysters	value	$275,000	$250,000	$210,000	$150,000
Vegetables	do.	$175,000	$200,000	$232,480	$174,483
Wool	pounds	450,000	450,000	340,000	325,786
Alabama coal	tons	30,594	30,810	19,598	8,189
Pennsylvania and English coal	do.	1,519	578	891	2,701
Bagging	rolls	32,539	20,939	18,471	9,257
Cotton-ties	bundles	100,786	13,337	49,686	42,315
Bacon	casks	14,383	7,856	7,482	8,829
Flour	barrels	115,069	109,003	100,079	90,013
Molasses	do.	3,152	4,447	5,084	5,773
Sugar	hogsheads	3,053	2,362	3,926	4,035
Whisky	barrels	5,644	6,204	5,945	7,954
Pork	do.	1,934	1,268	2,439	1,874
Fertilizers	sacks	137,251	88,193	97,433	57,062
Corn	do.	331,102	215,010	370,417	345,307
Bran	do.	63,250	47,491	55,491	43,996
Hay	bales	43,125	30,302	40,891	27,490
Tobacco	boxes	25,011	18,280	18,771	17,404

Comparative statement of shipments of cotton to foreign and coastwise ports.

Direction.	1885-'86.		1884-'85.		1883-'84.	1880-'81.
	Bales.	Value.	Bales.	Value.	Bales.	Bales.
Foreign (by vessel)	47,421	$2,116,766	43,830	$2,308,581	57,537	46,366
Coastwise (by vessel)	16,250	723,125	25,559	1,346,958	16,383	....
Interior (by rail)	199,976	8,898,932	190,095	10,016,006	186,991	224,894
Total,	263,647	11,738,823	259,484	13,671,545	260,911	271,260

Number and character of vessels engaged in the traffic of Mobile Harbor, Alabama.

Description.	1886.		1885.		1884.		1881.	
	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.
Steamers	4	546	4	558	4	491	4	877
Sloops	28	139	28	139	21	122	17	75
Schooners	70	1,311	70	1,311	59	1,189	24	843
Tugs	26	1,575	29	1,474	24	1,501	12	1,181
Barges	24	1,509	24	1,509	21	1,375	31	2,304
Fishing smacks	11	346	11	346	10	314	6	170
Total	163	5,426	166	5,337	139	4,942	94	5,540

Comparative statement of timber, lumber, &c., shipped by vessel to foreign and coastwis ports.

Description.	1886.		1885.		1881.
	Quantity.	Value.	Quantity.	Value.	Quantity.
Lumber:					
Foreign, feet, B. M	18, 628, 549	$209, 278	15, 388, 808	$178, 622	11, 531,
Coastwise, feet, B. M	5,835, 914	70, 030	6, 881, 895	75, 197	9, 587,
Total feet, B. M	24, 464, 463	279, 308	22, 270, 703	253, 819	21, 118,
Timber:					
Foreign, feet, B. M	36, 416, 664	339, 878	37, 443, 672	385, 426	20, 326,
Coastwise, feet, B. M	385, 451	3, 212	....	....	131,
Total feet, B. M	36, 802, 115	343, 090	37, 443, 672	385, 426	20, 457,
Shingles:					
Foreign .... number	494, 950	2, 233	686, 800	1, 545	3, 900,
Coastwise .... do	685, 000	3, 425	900, 000	2, 025	2, 169,
Total .... do	1, 179, 950	5, 658	1, 586, 800	3, 570	6, 069,
Staves:					
Foreign .... do	92, 469	10, 468	94, 261	11, 947	91, 4
Coastwise .... do	234, 216	....	150, 000	....	....
Total .... do	326, 635	10, 468	244, 261	11, 947	91, 4

The above statement was made up from clearances and such shipment by vessels having coasting licenses as could be obtained, but does not include any shipment by boats or railway to the interior, which is large.

Number of vessels entering and clearing at Mobile, Ala.

Description.	In port June 30.	Tonnage.	Cleared.	Tonnage.	Cargoes.				Ballast.			
					Foreign.		Coast-wise.		Foreign.		Coast-wise.	
					In.	Out.	In.	Out.	In.	Out.	In.	Out.
1881–1882.												
Steamships	....	....	3	1, 514	1	3	....	....	1	......	1	....
Ships	....	....	13	14, 802	1	12	1	......	10	......	1	1
Barks	9	3, 632	78	51, 642	4	63	5	6	64	......	4	[illegible]
Brigs	....	....	23	6, 127	4	10	7	18	3	......	9	....
Schooners	8	327	109	22, 675	24	50	17	53	9	1	67	[illegible]
Total	17	3, 959	220	96, 760	34	188	30	72	87	1	82	[illegible]
1884–1885.												
Steamships	....	....	4	2, 076	....	......	2	3		......	2	1
Ships	1	1, 135	11	13, 826	....	11	....	......	12	......	....	....
Barks	3	2, 203	118	79, 001	18	107	1	6	97	......	7	5
Brigs	....	....	17	5, 284	3	16	1	......	12	......	1	1
Schooners	14	3, 015	142	29, 944	49	55	52	63	23	2	32	[illegible]
Total	18	6, 353	292	129, 691	70	189	56	72	144	2	42	[illegible]
1885–1886.												
Steamships	1	757	18	8, 354	1	6	7	11	6	......	5	1
Ships	1	911	19	21, 410	1	18	...	......	19	1	.	....
Barks	3	1, 712	95	62, 742	5	89	3	4	83	1	4	1
Brigs	....	....	7	2, 452	1	5	2	1	4	......	...	1
Schooners	3	451	147	30, 709	29	54	66	75	17	4	24	14
Total	8	3, 831	286	125, 697	37	172	78	91	129	6	23	17

P 2.

IMPROVEMENT OF WARRIOR AND TOMBIGBEE RIVERS, ALABAMA AND MISSISSIPPI.

WARRIOR RIVER.

The examination and partial survey of this river was made in 1874, and the report thereon may be found in the Report of the Chief of Engineers for 1875, Part II, page 16.

In its original condition the river was well adapted for high-water navigation, having a width of 400 feet at Tuscaloosa, gradually reducing to 150 feet near its mouth.

For an average period of five months, during the winter and spring, the navigable depth ranged from 10 to 40 feet, and the chief difficulty experienced was from overhanging trees, which sometimes carried away the chimneys of steamboats and damaged their upper works. Below a 10-foot stage snags began to be troublesome, and when, as summer approached, the river receded to a stage 4 to 5 feet above low water, navigation for all practical purposes was brought to a close.

The obstructions to low-water navigation, rendering it impracticable, were:

First. Ninety-four bars and reefs that afforded generally a ruling depth of 18 to 30 inches, only, in some cases, shoaling to 12 inches.

Second. Numerous snags and sunken logs, occurring mainly in the narrow bar chutes, but frequently met with in the reaches also.

Third. Overhanging trees that, besides being troublesome in high stages, effectually closed narrow chutes, even had they been otherwise navigable.

The improvement of the Warrior was authorized by act of Congress of March 3, 1875, and the project recommended and approved was to deepen the bars, remove the snags, &c., and cut down the overhanging timber with a view of obtaining for small boats a low-water channel 80 feet in width by 4 feet in depth.

The estimated cost of the improvement was $151,103.

The work was commenced in 1875, and has been prosecuted annually for an average period of four months in each year, with results as hereinafter given.

WORK FOR THE YEAR ENDING JUNE 30, 1886.

There being but about $6,000 available for the year's work only a small force could be employed, which was stationed at Buzzard's Bar, 98 miles from the mouth of the river.

The work needed here was to slope and revet a caving bank.

The river here has a separate high-water and low-water channel. During the high stages the main current is over the bar, and the summer channel being in quiet water fills up. As the water falls in the spring, there comes a time when, before the chute scours out, the water on the bar becomes shoal and for a brief period there is no navigable channel, although the river is at a good boating stage, 6 to 8 feet above low water. Instances of this kind occur elsewhere, but the special difficulty in this case is that the receding bank (which has lost 200 feet since 1874) and the advancing point just above the chute have made a very abrupt turn necessary in order to enter the chute, and the case is aggravated as the bank yields, threatening to make the entrance impracticable for tows, if it is not already so.

The treatment proposed was to slope and revet the caving bank and afterwards to open a channel through the bar, allowing, and if necessary assisting, the summer chute to close up permanently.

As the thorough improvement of the river will require several miles of bank revetment, the work done here was somewhat experimental with a view to determine if a cheap method, without the use of rock (not generally obtainable), would answer the purpose. The method tried was to slope the bank (slope 1½ or 2 horizontal to 1 vert), and then to cover with brush 1 foot thick, laid on in lapping courses like shingles. Each course was held down by wires secured to stout pickets driven at 8 feet intervals by mauls, to a depth of 3 to 4 feet. The wires were stretched horizontally 6 feet apart. After standing for some time the pickets were again driven that the wires might press the brush close to the bank.

The brushing commenced at the top of the slope, the butts of each course overlapping the tops of the preceding one, the object being to place the fine brush in contact with the bank to check the flow of water along the slope's surface. The theory assumed was that the current being checked by the rough brush surface would deposit its sediment upon and under it, forming a rich nidus from which would spring a natural growth that in a few years would give a live and permanent brush protection, which once established, the decay of the wired brush would be of no consequence.

The cost of labor in sloping and revetting was—

For sloping banks	6.8 cents per square yard.
For cutting and boating brush (1 mile)	5.0 cents per square yard.
For making and driving pickets	1.6 cents per square yard.
For laying and wiring brush	2.8 cents per square yard.
Total	16.2 cents per square yard.

At the above rates the cost of this work, with banks, as in this case, 25 to 30 feet high, would be about $6,000 per mile.

With a suitable force and equipment (including a hydraulic grader) the cost would be materially reduced, probably to $4,000 per mile.

An examination of the above work in May, after its exposure to the winter floods, one of which was the highest known since 1833, indicated that the method used will succeed very well on this river. Here and there the brush had been a little disturbed (apparently by drift), and in one place it had been stripped from the bank (which was uninjured, however), but nineteen-twentieths of the work was intact and had, as hoped, become well silted up, and the numerous buds and sprouts appearing indicated that a natural growth would become well started during the coming summer.

Besides the work above mentioned, 250 logs were removed from the channel between Buzzard's Bar and Jennings' Ferry, a distance of 38 miles. Work closed on November 10 from exhaustion of funds, and the boats were floated down to Demopolis to lie up.

The original project called for the improvement of 94 bars and reefs, covering an aggregate distance of 14 miles out of a total length of river (Tuscaloosa to Demopolis) of 140 miles. Forty-nine bars, occupying an aggregate length of 4.64 miles, have been worked upon during those seasons in which the funds available were sufficient to equip and employ a force for this purpose.

The most essential work, and a necessary preliminary to bar improvement, being the removal of snags and logs, together with the cutting of overhanging timber, the means at hand have been every year largely, and in some seasons wholly, devoted to the prosecution of this work, which has proved of much greater magnitude than expected.

The original estimate of snags to be removed, made from actual count of those in sight, was a little less than 1,100, while up to this time over 7,700 have been taken out. More than 8,400 trees have also been cut from the banks. The work of removing snags and logs has been repeated several times over a great part of the river. This has been made necessary from the obstructions caused by the trees that are every year thrown into the river by land-slides and caving banks. It has also happened in many cases that after clearing a chute from logs, other underlying logs, becoming disengaged, would after a while rise at one end and form fresh obstructions.

The cause of this latter class of obstructions has nearly ceased to operate, but those of the others mentioned continue to act and will do so until stability shall have been given to the banks. The work for this purpose—sloping and revetting—was not originally contemplated, but the necessity for it has become apparent not only to keep the channel free from snags, but to give permanency to the improvements made.

It is thought that an aggregate length of 4 to 5 miles will cover the amount of bank revetment now needed.

The bars improved include all those that originally afforded a ruling depth of less than 2 feet. A deepening of 1 to 2 feet has been effected from scouring alone, induced by contraction of the channel. This contraction has not yet been made less than 100 feet, and in most cases 125 feet.

In order to accommodate the coal tows from the Upper Warrior, as explained in last year's report, these widths should not be reduced. In straight reaches a channel laid along the bank with a width of 100 feet may suffice, but in bends and crossings the limit should not be less than 125 feet.

The improvements thus far made have lowered the navigable stage fully 3 feet. This was demonstrated practically last fall by a steamer which made the trip to Tuscaloosa and returned with 600 bales of cotton on a stage hardly 2 feet above low water, the boat drawing at the time 4½ feet.

With a 125-foot channel a depth of 4 feet for the full width cannot be maintained on a low-water stage. For small light-draught boats this channel can be made navigable at all times, but for tows requiring 5 to 6 feet for the whole channel-width a stage of 4 feet above low water will probably be needed.

With open river navigation, improved as proposed, it is expected that the river will afford safe and easy navigation throughout the year, though during the low-water period the depth afforded will be sufficient only for light-draught boats. For tows drawing 5 to 6 feet uninterrupted navigation may be expected for six months, with boating stages occurring irregularly for three months more.

With the funds available for expenditure during the fiscal year ending June 30, 1887, it is proposed to continue the work of bank revetments, and probably complete it so far as it is at present needed. In connection with this work bar improvements and snagging will be carried on to such an extent as the requirements of the other works will permit.

This work, after completion, will require annual revision, for some years at least, at a cost of $8,000 yearly.

The commercial advantages expected are—

First. The reduction of freight rates, in consequence of competition between river and rail, amounting, as estimated in former reports, to $50,000 annually on the present business of the Warrior Valley.

Second. Doing away with the uncertainty, irregularity, and in great measure the risk heretofore attendant upon river transportation, and consequently reducing its cost.

Third. The utilization of the river as a channel for coal transportation to the Gulf.

Money statement.

July 1, 1885, amount available	$6,831
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	6,316
July 1, 1886, amount available	514
Amount appropriated by act approved August 5, 1886	18,750
Amount available for fiscal year ending June 30, 1887	19,264
Amount (estimated) required for completion of existing project	34,714
Amount that can be profitably expended in fiscal year ending June 30, 1888	34,714
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The business done on the Warrior and Tombigbee rivers during the fiscal year ending June 30, 1886, as far as could be ascertained, was:

Warrior River, Alabama.

10,388 bales of cotton, valued at	$415,
20,000 sacks of cotton-seed, valued at	15,
General merchandise (up freight)	280,
Total	710,

TOMBIGBEE RIVER.

The improvement of the Tombigbee in Mississippi was authorized by act of March 3, 1873, and its improvement below Columbus by act of March 3, 1875. Its continuance has been provided for by appropriations made for the Warrior and Tombigbee jointly.

The act of July 5, 1884, made two divisions of the Tombigbee, viz, "Fulton to Vienna" and "Below Vienna." This distribution is accordingly observed in this report.

In its original condition the river was navigated throughout the year to Bladen Springs, the ordinary limit of tide-water, 143 miles from Mobile. During low water, however, boats were liable to detention at four bars, where at low tide the depth was sometimes reduced to 2 feet. Moreover snags were troublesome, and at some points dangerous, so that they could be passed only in daylight.

From Bladen to Demopolis, 243 miles from Mobile, low-water navigation was difficult both from bars on which the boats grounded, and from snags and sunken logs. At times only 18 inches could be found on some of the bars, and then the boats turned back at Bladen.

From Demopolis to Columbus, 416 miles from Mobile, there were numerous bars affording only 12 to 18 inches at low water, and the channel throughout was much obstructed by snags. Overhanging trees were troublesome on all stages of water, and often inflicted damage.

Navigation was carried on only in the winter and spring, the high-water season, and ceased when the river fell to a stage 4 to 6 feet above low water.

From Columbus to Aberdeen, 481 miles from Mobile, navigation was difficult on a 12-foot stage; to Cotton Gin Port, 516 miles, it was practicable for barges only, and to Fulton, 593 miles, there was no navigation at all.

The project adopted for improvement was to open a low-water channel of navigable width having a minimum depth of 4 feet to Demopolis, and 3 feet thence to Columbus. From Columbus to Fulton the river was to be cleared of snags and overhanging trees for its improvement during the boating stages, open river navigation at low water not being considered practicable. The estimated cost of the improvement was $205,000.

The work was commenced in 1873, and the appropriation of $10,000 soon exhausted. It was not resumed until August, 1878, since which time it has continued during the low-water seasons for an average annual period of five months.

The time spent upon the work has been mainly devoted to snagging and bank-trimming, which are essential preliminaries to bar improvement. A considerable amount of the latter work has also been done during the three years in which the funds available allowed the employment of a force for that purpose.

The work for the year ending June 30, 1886, was limited in its amount from the fact that only $3,912.01 were available for the upper division, and $3,058.17 for the lower. As one small force could easily work out both these amounts during the season, the snag-boat "Big B" only was employed for the work on both divisions.

For the maintenance of the improvement above Columbus, however, which during low water is not accessible for steamboats, a small skiff party was engaged for a month in August and September in working over the river from Fulton to Aberdeen, 112 miles, in which fallen trees and slides had caused obstructions.

These were all removed, and the river left in a good navigable condition on a 4-foot stage, at a cost of about $500.

The "Big B" worked on the upper division from Vienna to the mouth of Big Creek, 5 miles below Pickensville, a distance of 38 miles, of which 5 miles was new work; 587 logs were taken out and 174 trees cut along the bank.

Commencing, then, at Vienna, on August 15, the "Big B" worked down-stream for 250 miles, removing the logs and obstructions that had developed in the past two years. Three hundred and seventy-eight logs were taken out and 174 trees cut. A wreck at the mouth of Sucamochee, which, owing to a shifting of the channel, had lately become a difficult obstacle to pass, was partially removed, leaving the channel clear. On the 20th of October work was suspended from exhaustion of funds, and the "Big B" was laid up in Mobile.

The present condition of the river is as follows:

First. *From Fulton to Vienna.*—From Fulton to Columbus, 177 miles, the proposed improvement has been completed, and the river is navigable down to a stage of 4 feet above low water. From Columbus to Vienna the river is navigable on a 2-foot rise for boats drawing 3 feet.

All of the river, except about 3 miles near Pickensville, has been well cleared of logs, of which 4,280 have been taken out. Twenty bars that originally afforded a depth of 12 to 20 inches have been improved and the depth increased to 3 feet. Five of these, however, have partially shoaled again from runbars and will need further work. Fifteen bars of 18 to 24 inches depth remain unimproved, and prevent low-water navigation.

Second. *Below Vienna.*—Four thousand one hundred and fifty-two snags and logs have been removed and the banks well trimmed of overhanging timber. This work, together with the bar improvements made, have given safe navigation with 3 feet depth at ordinary low water to Demopolis. On a 1-foot rise this depth can be carried to Kirkpatrick's, 260 miles, and on a 2-foot rise to Vienna. Eight bars below Demopolis, having originally a depth of 18 to 28 inches, have been improved and a depth of 4 feet obtained, but in two cases the gain has been partially lost. In both cases the depth can be readily restored.

Between Demopolis and Vienna 14 bars have been improved, on 11 of which a depth of 3 feet has been secured. Fifteen bars below Demopolis and 30 above remain to be improved before the channel will have the depth designed in the project. Until this is done the full benefit of the improvements made will not be felt. The railroad bridge at Jones's Bluff gives a difficult and unsafe passage for descending boats in consequence of a projecting rock bluff above the bridge which closes one draw-opening and throws a cross current through the other.

It is proposed to use the funds available for expenditure during the year ending June 30, 1887, above Vienna in completing the snagging and bank trimming over the unfinished 3 miles below Pickensville, and afterwards to take out the scattering logs that have accumulated between that point and Columbus during the past 2 or 3 years. Bar improvements will also be continued so far as the means afforded will permit.

Below Vienna it is proposed to complete the work of bar improvement between Mobile and Demopolis, or so much of it as may be found practicable.

The cost of the annual revision of the work for the maintenance of the improvement is estimated at $8,000.

The immediate commercial advantage that may be expected upon the completion of the improvement will arise, not so much from the increased amount of business done upon the river, as from the reduction of freight charges on the whole traffic of the Tombigbee Valley. When the freight tariff shall be regulated by competition between rail and river, maintained perennially, the advantage to the community of the improved river is to be measured by the amount of business affected by competition rates, and this will be all the trauportation business of the Tombigbee Valley, whether handled by river or rail.

The appropriations for this improvement have been made for the Warrior and Tombigbee jointly and for the Tombigbee above Columbus, as follows:

By act of March 3, 1873	$10,000
By act of March 3, 1875	25,000
By act of August 14, 1876	15,000
By act of June 18, 1878	40,000
By act of March 3, 1879	30,000
By act of June 14, 1880	51,000
By act of March 3, 1881	26,000
By act of August 2, 1882	31,000
By act of July 5, 1884	37,000
Total	265,000

Money statement.

Tombigbee River from Fulton to Vienna.

July 1, 1885, amount available	$3,912 01
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,788 98
July 1, 1886, amount available	123 03
Amount appropriated by act approved August 5, 1886	7,500 00
Amount available for fiscal year ending June 30, 1887	7,623 03
Amount (estimated) required for completion of existing project	6,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	6,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

Tombigbee River below Vienna.

July 1, 1885, amount available	$3,058 17
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,341 47
July 1, 1886, amount available	716 70
Amount appropriated by act approved August 5, 1886	11,250 00
Amount available for fiscal year ending June 30, 1887	11,966 70
Amount (estimated) required for completion of existing project	12,888 38
Amount that can be profitably expended in fiscal year ending June 30, 1888	12,888 38
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS, TOMBIGBEE RIVER.

86,426 bales of cotton, valued at	$2,557,040
5,000,000 feet timber, valued at	40,000
25,000 barrels rosin, valued at	50,000
5,500 barrels turpentine, valued at	82,500
1,500 cords stave timber, valued at	10,000
60,000 pipe staves, valued at	7,200
General merchandise (up freight), valued at	2,000,000
	4,746,740

P 3.

IMPROVEMENT OF BLACK WARRIOR RIVER, ALABAMA, FROM TUSCALOOSA TO DANIEL'S CREEK.

The survey of the Black Warrior River from Tuscaloosa to Sipsey Fork was made in compliance with the provisions of the act of Congress approved March 3, 1879, in the fall of 1879.

The report is contained in the Report of the Chief of Engineers, 1881, Part II, page 1218.

The plan of improvement recommended was by the use of locks and dams, at an estimated cost of $1,200,000, and an appropriation of $200,000 was asked for to begin the work with.

The river is at present navigable at high water only, and even then sufficiently dangerous to put a stop to all commerce on the river, although barges have been frequently floated down to Mobile loaded with coal.

The river and harbor act of July 5, 1884, appropriated $50,000 for the improvement of the portion of this river from Tuscaloosa to Daniel's Creek, a section embraced in the survey.

A survey for the purpose of locating locks and dams and to furnish data for the preparation of detailed plans and estimates was commenced in September, 1884, and report, with plans and estimates based thereon providing for a system of locks with movable dams, was submitted December 19, 1885. On January 25, 1886, a Board of Engineer Officers was ordered to convene to consider and report upon the project.

The Board met at Tuscaloosa, Ala., February 10, 1886, but did not approve the method, and recommended the improvement to be prosecuted under ordinary slackwater system, with locks and fixed dams.

Work was then commenced on preparation of plans and estimates for new project, which have been completed.

Should the locations, plans, and estimates under consideration be approved, it is proposed to apply the balance available and any amount that may be appropriated in prosecuting the work in accordance with those plans. The object of this improvement is especially for the transportation, in barges, of coal from the Warrior coal-fields. The enormous quantity of coal in the country through which this river flows, and its excellent quality and accessibility, prove conclusively the importance of the early completion of this improvement, rendering it available for the use of the General Government, the people of the Gulf States, and the steamers of all nations employed in the commerce of the Gulf.

Money statement.

July 1, 1885, amount available	$47,022 00
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	919 96
July 1, 1886, amount available	46,102 04
Amount appropriated by act approved August 5, 1886	56,250 00
Amount available for fiscal year ending June 30, 1887	102,352 04
Amount (estimated) required for completion of existing project	463,854 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	463,854 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

P 4.

IMPROVEMENT OF OLD TOWN CREEK, MISSISSIPPI.

The examination of this stream provided for by the provisions of section 3 of the river and harbor act of March 3, 1881, was made during the month of October, 1881, and report is contained in Annual Report of Chief of Engineers, Appendix K 29, 1881.

The condition of the creek when examined showed that the obstructions consisted entirely in accumulations of fallen trees, drift, and overhanging timber.

There were no shoals or rapids in the stream, and no artificial obstructions except a bridge 6 miles below City Point.

Prior to the construction of the Mobile and Ohio Railroad, boats run to Camargo, 16 miles from the mouth, and in 1852 or 1853 a steamer ascended within 2 miles of City Point.

The project recommended and adopted is to obtain a high-water channel for four months in the year, say from December 1st to May 1st, from the mouth of the creek to City Point, a distance of 30 miles, the object being to secure the opening of a competing route for the transportation of plantation products and return supplies.

The estimated cost is $10,000. The river and harbor act of August 2, 1882, appropriated $3,000 for this improvement, but the appropriation was not made available until March 1, 1883.

Owing to continued high water, operations were not begun until July 2, 1883, and were suspended, on account of near exhaustion of funds, during the following September.

The result of the work was such as to permit a steamer to make three trips to Camargo, bringing out 800 bales of cotton and 200 sacks of cotton-seed, carrying on her trips up about 20 tons of supplies and farming implements. About 500,000 feet of lumber in logs were floated down the stream to Columbus and Aberdeen.

As no appropriation has been made since, no further work has been done.

It is proposed to use any sum that may be appropriated in the future in continuing the removal of obstructions to high-water navigation, working as far up in the direction of City Point as the amount available will permit.

The benefits to commerce that would ensue from the completion of this improvement will be the opening of a water-way competing with the Mobile and Ohio Railroad, thus affording directly a more convenient and accessible route to the market, thereby materially decreasing freight charges on cotton and return supplies, as well as indirectly securing the advantages of competition.

It is estimated that about 34,000 bales of cotton now transported by rail will naturally seek this route or be carried by rail at reduced rates, and that a saving of $1.50 per bale on present railroad freights would follow, thus securing to the community an annual saving of $50,000 and a corresponding reduction on return supplies of 80 per cent. on value of the cotton.

No commercial statistics could be obtained for Old Town Creek, but it was probably the same as reported for year 1883 and 1884.

Money statement.

Amount (estimated) required for completion of existing project........	$7,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	7,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

P 5.

IMPROVEMENT OF NOXUBEE RIVER, MISSISSIPPI.

The examination of this river provided for by act of Congress approved March 3, 1879, was made during the month of March, 1880, and extended from Macon, Noxubee County, Mississippi, to its mouth.

Report is contained in the Annual Report of the Chief of Engineers for 1880.

The condition of the river when examined was such that during all seasons of the year, and at all stages of water, navigation, except by small flat-boats, was practically impossible.

Steamboats, prior to the building of the Mobile and Ohio Railroad, plied this river (1859). After the construction of this railroad the boats were withdrawn. The river banks then became overgrown with timber, much of which in time fell or slid into the river and caused the formation of a number of shoals and bars.

The river being virtually abandoned for the purposes of navigation, the planters living along its banks assisted in obstructing its channel-way by building a number of fish-traps and mill-dams.

The chief obstructions to navigation consisted in the immense number of trees overhanging the river throughout its entire length.

At the time of the examination the minimum depth of the river was found to be (at ordinary low water) from 1½ to 2 feet, and the average width 60 feet.

The project adopted was to afford a navigable channel for nine months in the year, from its mouth to the town of Macon, by the removal of overhanging timber from the banks, and such obstructions to navigation as might be found in the river.

The estimated cost was $65,245.25.

The appropriations made for the improvement are as follows:

By act of Congress approved June 14, 1880	$12,000
By act of Congress approved March 3, 1881	8,000
By act of Congress passed August 2, 1882	10,000
By act of Congress approved July 5, 1884	7,500
Total	37,500

Work on this improvement was commenced during the low-water season of 1880, prosecuted during the fiscal year ending June 30, 1881, and June 30, 1882, and through the month of March, 1883, when, the appropriation being about exhausted, operations were suspended.

Under the appropriation of $7,500 made by act of Congress approved July 5, 1884, work was resumed in September, 1884, and continued until January 12, 1885, when high water and extremely cold weather compelled a suspension of work.

On May 23, 1885, operations were again resumed and continued until June 30, 1885, and through the present fiscal year to the 23d of September, 1885, when work was suspended for want of funds.

Work during this fiscal year was commenced at a point 12½ miles above the mouth, and the river cleared to a point 27½ miles above, a distance of 15 miles. The condition of the improvement at the end of the fiscal year is a partially-improved channel the entire distance from the mouth of river up to Macon, and wholly from Macon to a point 28 miles below, and from the mouth to a point 27½ miles above, giving a river 55½ miles wholly and 36 miles partially improved.

The amount of work done during the fiscal year is itemized as follows:

Snags, logs, stumps, &c., removed	3,512
Trees trimmed	273
Overhanging limbs cut	641
Trees cut	760
Drifts removed	3

Any amount that might be made available in the future would be expended in completing the improvement of the 36 miles now only partially improved and in removing the snags and logs that have accumulated in that portion wholly improved since work was suspended.

On completing the improvement as designed, the river during high-water season will be navigable from its mouth to Macon, thus furnishing a new and cheaper transportation route for the planters along or adjacent to the river for their cotton produce and supplies, the greater portion of which is now hauled over heavy prairie roads long distances to the different stations on the Mobile and Ohio Railroad.

The work is not susceptible of permanent improvement, and will require an annual expenditure of at least $3,000 to maintain it in its improved condition.

The reduction in freight charges on cotton and produce that will naturally follow the opening of this river for navigation is estimated at about $20,000 per annum.

A corresponding decrease in the freight charges will also be felt in all lines of goods and merchandise transported, owing to the discrimination made between through and local rates by railroads.

The shipments over the river may possibly be also increased by the improvement furnishing the means of supplying coal to the inhabitants living near the river, from the coal fields of the Sipsey and Warrior rivers.

Commercial statistics have been written for to Gainesville, on Noxubee River, but no answer has been received.

Money statement.

July 1, 1885, amount available	$3,385 40
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,222 89
July 1, 1886, amount available	162 51
Amount appropriated by act approved August 5, 1886	7,500 00
Amount available for fiscal year ending June 30, 1887	7,662 51
Amount (estimated) required for completion of existing project	20,245 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	20,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

P 6.

IMPROVEMENT OF PASCAGOULA RIVER, MISSISSIPPI.

In 1873 a plan for the improvement of the river at its mouth by dredging a channel 100 feet wide and 8 feet deep at mean low water, with jetties on each side, was submitted by Lieut. James B. Quinn, Corps of Engineers, but owing to legal complications as to the ownership of what was then known as the "Noyes Canal," nothing was done under the plans and specifications then submitted.

In 1878, all fear of legal complications having been removed, an examination of the river was made under an appropriation, by act of June 18, 1878, of $10,000 for the improvement, $1,500 being allotted for the examination.

The plan adopted was the dredging of a channel 200 feet wide, 7 feet deep at mean low water, through the bar at the mouth of the river, and the removal of snags and overhanging trees throughout its entire length, at an estimated cost of $53,800.

At the commencement of the work there were from 3 feet to 3½ feet on the bar at mean low water, and the river was much obstructed by snags, logs, and overhanging trees.

The following appropriations have been made:

By act of June 18, 1878 ($1,500 for examination)	$10,000
By act of March 3, 1879	14,000
By act of June 14, 1880	20,000
By act of March 3, 1881	4,000
By act of August 2, 1882	8,000
By act of July 5, 1884	3,000
Total	59,000

Dredging operations, under contract with S. N. Kimball, were commenced July 18, 1880, $8,500 of the first appropriation ($1,500 having been used on the survey), and the whole of the second ($14,000) being available for this purpose. Funds were exhausted in January, 1881, and work suspended.

Work under this contract gave a channel through the bar 1 mile in length, 75 feet wide, and 7 feet deep.

Under the appropriation of $20,000, made by act of June 14, 1880, dredging was resumed, W. G. Mitchell, of New Orleans, La., being the contractor, in March, 1881, and was concluded in March, 1882. This completed the adopted project so far as related to the improvement of the bar at the mouth, securing a channel 180 to 190 feet wide, 7½ to 8 feet deep, and enabling vessels to go up to the mills at Moss Point and load, thus saving large lighterage bills and claims for demurrage. (A shoaling is reported to have taken place in the lower end of the dredged channel during the past year.)

During the spring of 1882 a log-boat, with steam capstan, was built in Mobile, towed over to the mouth of Pascagoula River, and in June of the same year the removal of snags, logs, and overhanging trees was commenced.

At the close of the fiscal year ending June 30, 1883, the river was partially improved from the mouth to Dead Lake, a distance of 50 miles.

The improvement during the fiscal year ending June 30, 1884, consisted in reworking the portion of the river already partially improved, and resulted in securing a navigable stream for vessels drawing 6½ feet, from the light-house to half a mile above Dead Lake, 50½ miles.

During the fiscal year ending June 30, 1885, 73½ miles of the river was worked, 15 miles reworked and wholly improved, leaving 58½ miles only partially improved.

Work was finally suspended on December 23, 1884, on account of exhaustion of funds, and boats and property placed in charge of a watchman.

The result of this work up to the 30th of June, 1886, has been to secure a navigable channel from the mouth of the river to one-half mile above "Dead Lake," 50½ miles, for vessels drawing 6½ feet, and to the junction of the Leaf and Chickasaha for vessels of lighter draught during six or eight months of the year.

It is proposed to expend such funds as may be appropriated for the fiscal year ending June 30, 1887, in continuing the work of improvement as heretofore prosecuted, removing such logs, &c., from the river, from Moss Point to Dead Lake, as may have lodged during the suspension of the work, and reworking that portion between Dead Lake and the junction partially improved during last fiscal year.

Since the beginning of the work of improvement large sales of Government and State lands have been made to capitalists adjacent to the river, and the continuance of the work will offer further inducements for investments for development of the resources of this richly-timbered section.

This improvement will not be permanent in its character, but will require an annual appropriation for the maintenance of its improved condition of about $2,500.

The improvement, even in its incomplete state, has already been of great benefit to the country depending for its trade upon the navigation of this river.

Money statement.

Pascagoula River.

July 1, 1885, amount available	$569 16
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	455 79
July 1, 1886, amount available	113 37
Amount appropriated by act approved August 5, 1886	25,000 00
Amount available for fiscal year ending June 30, 1887	25,113 00
Amount (estimated) required for preservation of improvement	2,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	2,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

Statistical statement of commerce of the port of Pascagoula, Miss., for fiscal year ending June 30, 1886.

Vessels.	Entrances.		Clearances.	
	No.	Tons.	No.	Tons
Foreign	58	35,719	60	36,825
Coastwise	67	14,609	81	14,716
American	29	5,918	29	5,265
Total	154	56,246	170	56,806

Fees	$1,185 51
Duties on imports	7 20
Tonnage dues	1,648 71
Hospital collections	105 00
Miscellaneous	17 23
Total collections	2,963 65
Exports to foreign ports	$386,084 33
Imports of foreign goods	36 00

P 7.

IMPROVEMENT OF HARBOR AT BILOXI BAY, MISSISSIPPI.

The examination of this roadstead, provided for by the third section of river and harbor act of March 3, 1881, was made during the months of August and September, 1881. The report is contained in the Annual Report of Chief of Engineers, 1882, Appendix K 27.

The examination showed that between the roadstead and the Back Bay are situated a series of mud flats, called "Deer Island Flats," distant about 1¼ miles east of Biloxi, having a present depth of 4 feet.

The improvement understood to be desired was to secure through these flats a channel 8 feet deep. The estimated cost of this work by dredging was $35,000. An appropriation of $5,000 for the improvement of this roadstead was made by act of Congress passed August 2, 1882.

No project was submitted, the amount appropriated being deemed insufficient for an economical prosecution of the work. Authority was therefore obtained under date of September 25, 1882, to defer all action until a further appropriation was made.

The river and harbor act of July 5, 1884, directed that the balance of the money heretofore appropriated for the roadstead, now on hand, be applied to the deepening of the channel from Mississippi Sound to the wharves of Biloxi.

The examination of this locality was made during the months of August and September, 1881, and report is contained in Annual Report Chief of Engineers, 1882, Appendix K 27.

The improvement understood to be desired is the deepening of the channel from Mississippi Sound to the wharves at Biloxi, from 4½ feet, the least depth at present, to 8 feet at mean low water.

The improvement can be accomplished by dredging, and a channel 150 feet wide and 8 feet deep at mean low water obtained for about $55,000, but it is not believed that it would be permanent.

Authority was obtained, under date August 27, 1884, to hold the appropriation until a further one is made sufficient to permit an economical prosecution of the improvement contemplated.

No work has been attempted, nor is any proposed, until further appropriations are made.

Such sum as Congress may appropriate for expenditure during the fiscal year ending June 30, 1887, together with amount now on hand, will be applied to deepening the channel as proposed from 4½ to 8 feet.

The increase of commerce likely to ensue from the completion of this improvement would be impossible to estimate at present. Commercial statistics have been requested from the collector of customs at Biloxi, but have not been furnished.

Money statement.

July 1, 1885, amount available	$4,988 55
July 1, 1886, amount available	4,988 55
Amount appropriated by act approved August 5, 1886	12,500 00
Amount available for fiscal year ending June 30, 1887	17,488 55
Amount (estimated) required for completion of existing project	37,500 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	37,500 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

P 8.

IMPROVEMENT OF HORN ISLAND PASS, MISSISSIPPI.

The examination of this locality was made during the months of August, and September, 1881, and report is contained in Annual Report Chief of Engineers, 1882, Appendix K 28.

This pass is the nearest outlet to sea for all vessels loading at Pascagoula, Miss., and the object desired is to obtain 21 to 22 feet depth through this pass at mean low water, thus enabling vessels drawing more than 17 to 18 feet to complete their loads near Pascagoula, saving the cost of a long, expensive, and dangerous tow, 25 miles to Ship Island, Mississippi, where they are now obliged to load.

The proposed improvement of the pass would allow them to load within 9 miles of their principal source of supply.

The present depth of the pass is over 16½ feet at mean low water (the exact depth is unknown as it is deepening constantly and no recent soundings have been made).

The improvement, if required, can be made by dredging, and the estimated cost for a channel 100 feet wide, 21 feet deep, was $43,000 at the time of the examination.

An appropriation of $5,000 was made by the river and harbor act of July 5, 1884, for the improvement of this pass.

No project was adopted as the amount was deemed inadequate to an economical prosecution of the work. Authority was therefore obtained to hold this appropriation until one sufficient for economical work has been made.

Nothing has therefore been done during the present fiscal year, nor will anything be attempted until further appropriations are made.

It is probable no improvement will be needed at this point, owing to the increase in depth from natural causes.

Money statement.

July 1, 1885, amount available	$5,000 00
July 1, 1886, amount available	5,000 00

Statement of vessels entered and cleared through Horn Island Pass during fiscal year ending June 30, 1886.

Nationality.	Entered.	Cleared.
Foreign	58	60
American	29	29
Total	87	89

P 9.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, BELOW JACKSON.

The original project for improving this part of the river was adopted in 1880, the object being to obtain a navigable channel 5 feet deep, at low water, from Jackson down to the mouth by the removal of snags, stumps, roots, and sunken trees, and the clearing of the banks of overhanging trees, at an estimated cost of $95,940, based upon the report of a survey made under direction of Capt. C. W. Howell, Corps of Engineers, by Mr. H. C. Collins, the assistant engineer in charge, in March and April, 1879, at a stage 10 feet above low water.

Congress, by act approved July 5, 1884, included the bar at the mouth of the river, the rough estimate of the cost of improvement of which is $20,000.

The following appropriations have been made:

By act June 14, 1880	$30,000
By act March 3, 1881	25,000
By act August 2, 1882	15,000
By act July 5, 1884	10,000
Total	80,000

After due advertisement a contract was entered into October 7, 1880, with S. N. Kimball for the improvement of 195 miles of the river from Jackson down.

Owing to high water the contractor was unable to complete his work within the time specified, January 1, 1882, and an application for extension of time to January 1, 1883, was approved.

Under the appropriation of $25,000 made by act of March 3, 1881, a project for the expenditure of this amount was submitted and approved.

After due advertisement a contract was entered into with G. A. Meyers for the improvement of 100 miles more of the river, commencing at a point 195 miles below Jackson, the end of Kimball's work.

On July 27, 1882, the work was reported finished, but an inspection showed that it was not in accordance with specifications, and the contractor resumed work. August 23, 1882, the work was accepted.

Two hundred and ninety-five miles of this part of the river were somewhat improved, and there remained from 15 to 20 miles of bad river near the mouth upon which no work had been done.

Under the appropriation of $15,000, made by act of August 2, 1882, the amount was to be expended under the supervision of the United States Engineer Office by hired labor.

In November, 1883, the work was for various reasons suspended. A watchman was placed on the plant to take care of the property.

The work accomplished by hired labor was the closure of twelve run-out bayous by levees and piling, the cutting of 120 snags, and the girdling of 700 trees on the banks.

Under the appropriation of $10,000 made by act of July 5, 1884, the work on the improvement of this part of the river was continued by hired labor till September, 1884. In accordance with instructions from the Chief of Engineers, United States Army, dated Washington, D. C., July 8, 1884, this work was transferred by Maj. Amos Stickney, Corps of Engineers, United States Army, to Maj. A. N. Damrell, Corps of Engineers, United States Army.

The sum of $5,154.83 was transferred by Major Stickney.

Ten thousand dollars appropriated by act of Congress approved July 5, 1884, was also available, making a total on hand at the transfer of $15,154.83.

From September to December 1, 1884, operations on this part of the river were suspended and a watchman was employed.

Work was again commenced December 1, 1884, and continued whenever the stage of water permitted working to advantage, June 30, 1885, at which time the condition of the improvement was as follows:

Two hundred and ninety-five miles of this river, from Jackson down to Poitevant's Bluff, had been partially improved by contract; 15 miles of this distance, from the head of West Pearl down to lower end of Homes Bayou, had been reworked by hired labor, but the improvement had not been completed.

During the fiscal year ending June 30, 1886, operations were continued from June 30, 1885, to March, 1886. The work consisted in widening and deepening a cut-off three fourths of a mile above the head of West Pearl, removing snags, overhanging timber, and log-jams, and partially closing 8 sloughs and run-out bayous on that section of the river from the head of West Pearl to the mouth of Homes Bayou, detailed as follows:

	Number.
Stumps removed	717
Roots removed	1,271
Snags removed	1,767
Sunken logs removed	1,130
Sunken trees removed	846
Cypress knees removed	45
Overhanging trees removed	8,382
Cubic yards of clay and sand removed	2,752
Running yards of cane removed	7,838

The large drift of logs and trees that was placed and secured across the head of West Pearl during the last fiscal year was increased, willows were planted, and several hundred large trees were felled into the river below the drift, so as to lessen the current and cause sand-bars to form.

March 30, 1886, operations on this part of the river were suspended and the derrick, snag, and quarter boats were carried up the river to Wakiah Bluff and laid up. A watchman was placed in charge to take care of the property.

The condition of this part of the river has been greatly improved by the work done, particularly Homes Bayou, which before the improvement had always been considered the worst part of the whole river, steamboats taking from six to eight days to pass through, while since the improvement they go through in four hours. The river below Homes Bayou to the mouth has not been improved.

The condition of the cut-off near the head of West Pearl has greatly changed and improved during the year. It is widening and deepening. The only obstacle that seems to prevent steamboats from using it during high water is the very strong current, which boats are unable to stem. It can be reasonably expected, however, that when, either by washing and scouring or by additional work, this cut-off has attained a minimum width of, say, 150 feet, and the same depth as found above or below, the current will not be any stronger than is found in other parts of the river.

A number of sand-bars and shoals that had formed within the last six years below the cut-off are now deepening on account of the increased volume of water and current due to the opening of the cut-off above. Nearly all the jetties and dams constructed and piles driven heretofore across a number of run-out bayous, between the head of West Pearl, East Pearl, and Homes Bayou, have been damaged.

The condition of the river above the cut-off as far as Jackson, Miss., is about the same as when left by the contractors, and can be navigated only safely on a 6 or 7 foot rise.

The benefits derived by the improvement of the river effected up to June 30, 1886, are as follows:

Greater security to navigation between New Orleans, La., and Jackson, Miss., and reduced freights on merchandise and produce.

A large proportion of the cotton, merchandise, &c., were before the improvement hauled from Georgetown, Columbia, Monticello, and other towns and settlements located on the river to the nearest railroad station on the Illinois Central and Northeastern railroads, a distance of from 20 to 40 miles.

Freight on a bale of cotton shipped in this way to New Orleans, La., was $4.80; a barrel of flour shipped in this way from New Orleans to Columbia or Monticello, $2.

Freight on a bale of cotton shipped down the river by boats, delivered at New Orleans, La., costs now $1.50; a barrel of flour, 60 cents; other freights in proportion.

This shows there is a very large reduction and saving in freights by river competition by the improvement of the river.

It is proposed to apply the amount appropriated for the next year to the deepening and widening of the cut-off situated near the head of West Pearl River, to the closing effectually of Fan Slough, Parker's Bayou, Twin Bayou, and Little Homes Bayou, and the improvement of the river between Homes Bayou and the mouth and that part of the river above the cut-off near the head of West Pearl, towards Jackson, Miss., so as to obtain a 2-foot channel at low water as far up as the amount available will permit.

In addition to the improvement of the river proper, the increased lumber trade of the mills situated on the river, particularly that of Messrs. Poitevant & Favre, at Pearlington, Miss., located about 12 miles above the mouth of East Pearl River, demands the deepening of the bar at the mouth by dredging.

Vessels of 7 feet draught of water can be loaded at the mills on the river, but the lumber for vessels of heavier draught, of which there are a large number loaded at the mills, must now be lightered and towed over the bar, which not only causes great delay, but heavy expenses.

It is desired by mill-owners and those interested in the lumber business on the river to obtain a 12-foot channel over the bar. After vessels cross the bar there is sufficient water up to the mills to load down to 12 feet.

The estimated cost of dredging a channel 12 feet deep at mean low tide over the bar at the mouth of East Pearl River is $20,000.

Owing to the caving in of banks after freshets, as also to the shifting of the channel, the improvements so far made and contemplated will not be permanent.

An annual appropriation of $5,000 would be sufficient to maintain the river in the condition contemplated by the plan of improvement.

The amount asked for this work is in excess of the original estimate. The reasons are as follows:

First. The survey of the river upon which the original estimate was based was made at a stage 10 feet above low water. The result was a decided underestimate of the amount of work and cost.

Second. A large portion of the work was done by contract, and so done by the contractors as to require reworking.

Third. The obstructions forming each year of snags, sunken logs, and overhanging trees requiring removal were not included in the original estimate, but are included up to date in the proposed modification of existing project. The extent of the anticipated excess is $50,000.

Money statement.

July 1, 1885, amount available	$8,380 01
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	8,378 56
July 1, 1886, amount available	1 45
Amount appropriated by act approved August 5, 1886	12,625 00
Amount available for fiscal year ending June 30, 1887	12,626 45
Amount (estimated) required for completion of proposed modification of existing project	70,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	50,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Number of vessels entered, cleared, and loaded, Pearl River, Mississippi.

Character of vessels.	American.	Foreign.	Tonnage.
Ships	1	....	600
Barks	....	8	1,400
Brigs	2	....	600
Schooners	54	....	9,400
Total	57	8	12,000

Number of vessels employed lightering lumber from Pearl River, Mississippi.

Character of vessels.	No.	Tons.
Steamers	6	250
Schooners	18	720
Barges	3	240
Total	27	1,210

Statement of lumber shipped from Pearl River.

Direction.	Superficial feet.
Shipped to exportation	20,287,967
Shipped to dealers	24,050,000
Shipped to foreign and coastwise	9,226,829
Total	53,564,796

Imports via Pearl River.

Articles.	Tons.
Mahogany and cedar	1,500
Dye-woods, &c	550
Hemp	250
Bones	400
Total	2,700

Statement of vessels employed on Pearl River below Jackson.

Character of vessels.	Number.	Tonnage.
Steamboats	6	500

Statement of staple articles transported on Pearl River below Jackson to and from New Orleans, La., and to saw-mills near the mouth.

Articles.		Number.
DOWN-STREAM.		
Cotton	bales..	2,500
Rice	barrels..	1,200
Rosin and turpentine	do....	2,200
Staves	number..	8,000
Fire-wood	cords..	3,500
Saw-logs	number..	120,000
UP-STREAM.		
Fertilizers	tons..	5,000
Grain	do...	250
Machinery, &c	do...	100
General merchandise	do...	20,000

Statement of staple articles transported on Pearl River below Jackson for preceding year, 1884–1885.

Articles.		Number.
DOWN-STREAM.		
Cotton	bales..	3,000
Rice	barrels..	150
Staves	number..	10,000
Fire-wood	cords..	2,500
Saw-logs	number..	200,000
Square timber	cubic feet..	50,000
UP-STREAM.		
Fertilizers	tons..	300
Grain	do....	250
Machinery, &c	do....	100
General merchandise	do....	500
Total		1,150

P 10.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, FROM JACKSON TO CAR-THAGE.

An examination of this part of the river was made under the direction of Capt. C. W. Howell, Corps of Engineers, United States Army, in 1879.

The original project for the improvement of this part of the river consisted in the removal of snags, logs, and overhanging trees, and to afford a channel of navigation 5 feet deep at a low stage of the river from Jackson to Carthage, a distance of 105 miles, at an estimated cost of $21,000.

This amount is not sufficient to clear the river of obstructions so as to give safe navigation during a low stage of water.

The original estimate should be increased $29,000.

The reason for the increase in the expenditure over the original estimate is that the examination was made at a high stage of water, when many of the obstructions could not be seen, and the estimates were based on the report of the examination.

The following appropriations have been made:

By act March 3, 1879	$6,000
By act June 14, 1880	7,500
By act March 3, 1881	2,500
By act August 2, 1882	2,500
Total	18,500

Under the appropriation of $6,000 made by act of March 3, 1879, a contract was entered into with J. S. Hamilton, November 20, 1879, for the improvement of this part of the river.

Under the appropriation of $7,500, made by act of June 14, 1880, another contract was made with J. S. Hamilton to continue the work.

Under the appropriation of $2,500, made by act of March 3, 1881, after due advertisements no bids were received, and the amount was allowed to stand awaiting further appropriations sufficient to warrant commencement of work.

Uunder the appropriation of $2,500 made by act of August 2, 1882, a project was submitted August 17, 1882, to continue the work by hired labor, which was approved.

The work under the Hamilton contract did not prove satisfactory, and the contracts were annulled September 22, 1882.

On July 8, 1884, the work was in accordance with instructions from the office of the Chief of Engineers, United States Army, transferred by Maj. Amos Stickney, Corps of Engineers, United States Army, to Maj. A. N. Damrell, Corps of Engineers, United States Army, and the improvement was carried continuously down-stream to a point 12 miles below McFadden's Ferry, at Carthage. In the balance of the river down to Jackson, 93 miles, only the worst and most dangerous places were partly improved. The entire distance requires working over again.

In January, 1885, the appropriation being exhausted, the derrick and quarter-boats were carried down-stream to Wakiah Bluff, the boats and machinery overhauled, and the boats laid up to be used on the improvement of the river below Jackson.

Before the improvement, even during high water, steamers could not make more than two trips a month between Jackson and Carthage, while since the improvement boats make four and five trips a month.

The condition of the river on June 30, 1886, was as follows: 12 miles from Carthage down-boats of 3 feet draught of water can navigate with comparative safety at a stage of river 4 feet above ordinary low water.

In the other part of the river, down to Jackson, boats can navigate on a 6-foot rise above ordinary low water.

The improvement of this part of the river is not permanent, but will have to be worked over again from time to time, owing to the caving in of banks and the shifting of the channel.

No work was done on this part of the river during the fiscal year ending June 30, 1886.

An annual expenditure of $2,400 would maintain the river in the condition contemplated by the plan of improvement.

As there was only one steamer, the O. R. Singleton, navigating between Jackson and Edinburg, making Carthage only a way landing, the commercial statistics for this part of the river are the same as for that portion between Edinburg and Carthage. They have been asked for, and when received will be completed and forwarded as a supplementary report.

Money statement.

July 1, 1885, amount available	$52 40
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	52 40
Amount appropriated by act approved August 5, 1886	2,250 00
Amount available for fiscal year ending June 30, 1887	2,250 00
Amount (estimated) required for completion of existing project	29,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

P 11.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, BETWEEN EDINBURG AND CARTHAGE.

A survey of this part of Pearl River was made under direction of Maj. Amos Stickney, Corps of Engineers, United States Army, during the month of November, 1883.

The original project for the improvement of this part of the river is to afford a high-water channel from Edinburg to Carthage, a distance of 24¾ miles, for six or eight months of the year, at an estimated cost of $13,464.

There is no navigable channel in the greater portion of this part of the river during low water. Although high banks are found on both sides of the river, yet the river is so obstructed by fallen trees, snags, roots, logs, sand and mud bars, and overhanging trees, that navigation by the steamer O. R. Singleton, built for this trade in 1883, was only possible during very high water.

Under an allotment of $2,500, made by act of July 5, 1884, work on this part of the river was commenced at Edinburg on the 17th of November, 1884, and continued until the 23d of January, 1885, when the river becoming too high for working to advantage, operations were suspended.

Nineteen miles of this part of the river, from Edinburg down, were partially improved. On the 3d of September, 1885, operations were resumed. Commencing 19 miles below Edinburg, the work was carried down to Carthage, 5¾ miles. Such stumps, roots, logs, and trees as were found most in the way were removed by cutting and blasting. On September 30, 1885, the appropriation being nearly exhausted, operations were suspended and the plant and property stored at Edinburg.

The method of improvement is the removal of obstructions from the channel and clearing of the banks of overhanging trees by hired labor and purchase of material.

The amount of work accomplished on this part of the river during the fiscal year ending June 30, 1886, is as follows:

Number of stumps blasted and removed	70
Number of sunken logs and trees cut	100
Number of overhanging trees removed	172

A large amount of drift and brush were also removed.

Owing to the continual washing of banks, causing trees to fall in, the improvement made will not be permanent. It is estimated that an annual expenditure of $500 will maintain the river in the condition contemplated by the plan of improvement.

Considerable benefit was derived from the work so far done, as shown by the fact that before the improvement the time consumed by the steamer ascending the river from Carthage to Edinburg averaged six days, while after the partial improvement the steamer made several trips in twelve hours.

The condition of the improvement on June 30, 1886, was such as to allow boats of 3½ feet draught of water to navigate the river between Edinburg and Carthage with comparative safety on a rise of 8 feet above low water.

Before the improvement, most of the produce and merchandise had to be hauled by wagons between Edinburg and railroad stations a distance of from 40 to 60 miles.

The reduction and saving in railroad freights by river competition due to improvement is considerable, as shown by the following exhibit: Freight on a barrel of flour from Mobile, Meridian, or New Orleans, delivered at Edinburg, was, before the improvement, $2; now it is 60 cents. The saving in freight on a ton of fertilizer is $5, on a bale of cotton $4. It is estimated that the aggregate saving in freights annually to the farming interests of the county adjoining the river, due to the improvement, will not fall short of $30,000.

Only one boat, the steamer O. R. Singleton, has been employed on this part of the river during the fiscal year. Her dimensions are, length, 95 feet; tonnage, 110; draught of water, 4½ feet.

Money statement.

July 1, 1885, amount available	$389 61
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	389 06
July 1, 1886, amount available	55
Amount appropriated by act approved August 5, 1886	2,250 00
Amount available for fiscal year ending June 30, 1887	2,250 55
Amount (estimated) required for completion of existing project	10,964 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Improving Pearl River, Mississippi, between Edinburg and Carthage, during the fiscal year ending June 30, 1886.

Articles.		Number.
UP-STREAM.		
Fertilizers	tons	140
Machinery, &c	do	200
General merchandise	do	200
Grain	do	120
DOWN-STREAM.		
Cotton	bales	750
Wool	do	90
Staves		7,000
Poultry eggs, &c	dozens	1,830
Saw-logs		8,500
Firewood	cords	300

P 12.

PRELIMINARY EXAMINATION OF PASCAGOULA RIVER, MISSISSIPPI, FROM THE MILLS AT MOSS POINT DOWN TO THE ANCHORAGE IN THE BAY, WITH A VIEW TO SECURING A UNIFORM DEPTH OF TWELVE FEET OF WATER.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., October 17, 1884.

GENERAL: I have the honor of submitting the following report upon the preliminary examination of "Pascagoula River, from the mills at Moss Point down to the anchorage in the bay, with a view to securing a uniform depth of 12 feet," ordered by circular letter of July 31, 1884.

The distance from Moss Point to the 12-foot curve in Mississippi Sound is about 11 miles.

There is generally over 12 feet of water in the Pascagoula River, but there are at least two bars between Moss Point and the New Orleans and Mobile Railroad Bridge, about 500 feet in length, each with a minimum depth of only 8 feet.

There is a channel through the bar at the mouth of the river 180 feet wide and nearly 8 feet deep, obtained by dredging from 1880 to 1882.

In my opinion this river is worthy of improvement, for the following reasons:

The cost of the work would not probably exceed $200,000.

The commerce to be benefited is large, as will be seen from the following statement:

Vessels cleared for foreign countries from June 30, 1883, to June 30, 1884	136
Vessels cleared, coastwise	43
Total	179
Tonnage of foreign clearances	68,425
Tonnage of coastwise	14,615
Total	83,040

Value of exports from June 30, 1883, *to June* 30, 1884.

Articles.		Quantity.	Value.
Foreign:			
Lumber	superficial feet	38,635,542	$516,916
Timber	cubic feet	1,997,848	87,052
Total		40,633,390	603,968
Coastwise:			
Lumber	superficial feet	6,741,208	53,929
Total exports		....	657,897

In 1880, before the improvement above mentioned was accomplished, the commerce was as follows:

Direction.	Vessels entered.	Vessels cleared.	Tonnage (entrances).	Tonnage (clearances).
Foreign	61	64	23,831	24,[illegible]
Coastwise	23	37	5,301	8,[illegible]
Aggregate	84	101	29,132	32,[illegible]

Thus showing a large increase, and it is believed that the increase in the depth of the channel to 12 feet will result in a still larger increase.

The estimated cost of the survey is $2,400.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Major, Engineers.

The CHIEF OF ENGINEERS, U. S. A.

SURVEY OF PASCAGOULA RIVER, MISSISSIPPI, FROM THE MILLS AT MOSS POINT DOWN TO THE ANCHORAGE IN THE BAY, WITH A VIEW TO SECURING A UNIFORM DEPTH OF TWELVE FEET OF WATER.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., January 30, 1886.

SIR: I have the honor of transmitting the report of Mr. R. Rauchenstein, assistant engineer, upon the survey of the Pascagoula River, Mississippi, from Moss Point down to the anchorage in the bay, with a view to securing a uniform depth of 12 feet of water.

The places between the limits specified having less than the required depth are Chammier Shoals, 2 miles below Moss Point, about 3,200 feet long, with a minimum depth of 9 feet; two small shoals above and two small shoals below the railroad bridge at Scranton, 1½ miles above its mouth, with a minimum depth of 7½ feet on them, and the bar at the mouth, with a minimum depth of 7½ feet at the time of the survey, and 4 miles long from the 12-foot curve inside to the 12-foot curve in the anchorage.

A channel of navigable width and minimum depth of 12 feet from Moss Point to the anchorage in the bay, a distance of about 11½ miles, can be obtained by dredging, which, while it would not be permanent, could be maintained at small expense.

The estimated cost of the work is $78,100. The object of the improvement is saving the lighterage in allowing vessels to proceed to the mills for full or partial loads.

The present commerce to be benefited is shown by the following statement:

A considerable increase would probably follow upon the completion of the proposed improvement, but no reliable estimate can be made as to the amount of the increase.

The following tracings are forwarded:

General map of survey, detail sheets Nos. 1, 2, 3, 4, which, together with report of Mr. Rauchenstein, above mentioned, will show details of work and estimate.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Major, Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. R. RAUCHENSTEIN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., January 20, 1886.

SIR: In pursuance of your instructions of December 12, 1884, I have the honor to submit herewith my report on the results of the survey of Pascagoula River, Mississippi, made for the purpose of estimating the cost of opening a 12-foot channel from the "mills at Moss Point down to the anchorage in the bay," authorized by act of Congress approved July 5, 1884.

The accompanying tracings of a general map of that section of Pascagoula River and Mississippi Sound embraced in the above survey, and detailed sheets of different sections of the same, will fully explain the topography, as well as hydrography, deemed necessary for the purpose of making the desired estimate. All soundings are reduced to mean low-water gauge used during dredging operations, 1882, 1883, which seem to agree with the one established by United States Coast Survey.

The Pascagoula River, from the mouth of Big Dog River (on which latter stream all the saw mills are located) to the sound, at ordinary stages of water, is a tidal river; the ordinary rise and fall of the tide is 1.3 feet. The current during flood tide at no time exceeded 1¼ miles, while during ebb tides, at times, exceeded 4 miles. On account of unfavorable weather no accurate current observations could be made. I am satisfied, however, that with a normal width of river a 12-foot channel once opened, although not permanent, may be maintained at a very small expense.

Considering the present condition of the channel, the soundings show that, starting from the mouth of Big Dog River, a short distance above which some of the Moss Point saw-mills are situated, the channel of the Pascagoula River has a sufficient width and depth for a distance of about 2 miles, to Chammier Shoals, where the river makes a bend to the left, changing its westerly to a southeasterly course, and its width at this bend increases from 900 feet above to about 1,500 feet, and is divided by a small island, near the west bank in the elbow of the bend, into two channels. The one on the east side, being about 1,000 feet wide, forms a shoal about 3,200 feet long, through which there is a channel, now used by the boats, with a minimum depth of 9 feet.

The channel on the west side of the island, about 500 feet wide, although deepest behind and below the island, is practically closed at and immediately above the head of the island, caused by an accumulation of sunken logs, timber, &c. The length of the shoal along the west bank, from the 12-foot curve above to the 12-foot curve behind the island, is 2,100 feet.

Two projects are submitted for the opening of a 12-foot channel through this shoal:

(1) For opening west channel. To dredge a 100-foot channel along the western shore and connect the deep water above with the 12-foot curve behind the island, depositing the material along the west bank for its protection, and contract the enlarged cross-section of the river at the head of the island by a submerged jetty extending from the eastern shore about 500 feet into the river.

(2) For opening east channel. To close the channel on the west side of the island by a pile dam from near its upper end to the western shore, and deepening the channel on the east side of the island by dredging, should the increase of the velocity of the current produced by the closing of the west channel prove insufficient to deepen the present east channel by scouring.

My estimate is based upon the adoption of the first project, of opening the west channel, and will fully cover the cost of the second, or east channel, should it be adopted.

Between this shoal and the mouth of the river, a distance of 5.11 miles, we encounter four small shoals, two above and two below the railroad bridge which spans the river at Scranton, about 1¼ miles above its mouth, offering, however, with its two 80-foot draw openings, no impediment to the navigation of the river. A channel will have to be dredged through the four shoals mentioned, the cost of which is included in the estimate.

At the mouth of the river, opposite the town of East Pascagoula, on the east and a short distance to the northward of the light-house on the west, we strike the bar, the dredging through which for a 12-foot channel extends continuously to the 12-foot curve in the anchorage, a distance of 4 miles.

During the years 1882 and 1883 a cut with 7.5 feet depth of water and about 180 feet wide was dredged through the crest of the bar, sweeping from a north and south course in the river, in a continuous curve, to an east-southeast course at its southern end, and in locating the new or 12-foot channel to the anchorage, advantage was taken as much as possible, without making unnecessary curves, of this former cut, as the general map or detail sheet will show.

The direction of this cut is southeast, chosen to correspond with the direction of the current of the ebb tide at the time of its location, the prevailing wind being north; the estimate, however, will cover any slight change that may have to be made upon more extended current observations, which bad weather prevented me from making.

The estimate of cost of this improvement is made for 100 feet width in bottom of cut, with slopes of 1 in 3 and 1 in 2, according to nature of material, which consists on the outer slope of the bar of soft bluish mud, mixed with sand, while on the inner slope and through the shoals in the river this material is covered with a layer of sand more or less compact from 1 to 2.5 feet thick.

The above-described work comprises all the dredging required for a 12-foot channel from the lower mills at Moss Point to 12-foot water in anchorage in the Mississippi Sound for the improvement of Pascagoula River only.

In order to reach all the saw-mills at Moss Point, on Big Dog River, with 12 feet of water, a small shoal on the north side of an island, a short distance above the confluence of the two rivers, will have to be dredged, and as the amount required to do this work is small, I have included it in the estimate.

I have estimated the dredging at three different prices, viz, at the bar and lower portion in the river, where a large amount of work has to be done, 15 cents per cubic yard, the average distance to dumping-ground not exceeding 3 miles. At Chammier Shoals, where the dredged material has to be deposited on west bank of channel, cost estimated is 60 cents per cubic yard, and at island in Dog River, where only a small amount of work is required, the price is 25 cents per cubic yard, distance to dumping-ground being about 3 miles.

ESTIMATE OF COST OF SECURING A 12-FOOT CHANNEL FROM THE MILLS AT MOSS POINT TO THE ANCHORAGE IN THE BAY.

Excavation through the bar at the mouth of the river, 361,280 cubic yards, at 15 cents	$54,190
Excavation through the four shoals in lower part of river, 48,820 cubic yards, at 15 cents	7,323

Excavation at Chammier Shoals for opening west channel, 29,400 cubic yards, at 60 cents	$17,640
500 feet submerged jetty, at $4.50	2,250
Excavation at island in Dog River, 5,660 cubic yards, at 25 cents	1,415
Superintendence and contingencies, 10 per cent	8,282
Total	91,100

Should project No. 2 be adopted for deepening the east channel and closing the one west of the island at Chammier Shoal, a deduction of at least $13,000 can be made from the above estimate.

As to the benefit to be derived by the saw-mill interest at Moss Point from the proposed improvement, it would no doubt greatly increase the coastwise lumber trade, as probably all vessels engaged in that trade could ascend the river and load at the mills and thus save lighterage, but as to the extent of the increase in this trade and the actual benefit to be derived therefrom I am unable to form an opinion, as no reliable statistics could be obtained in regard to it.

This contemplated work is located in Jackson County, Mississippi, collection district of Shieldsboro', with a deputy collector at Scranton, Miss., from whom the following statistics in regard to the lumber and timber trade in his district have been obtained.

Very respectfully, your obedient servant,

R. RAUCHENSTEIN,
Assistant Engineer.

Maj. A. N. DAMRELL,
Corps of Engineers, U. S. A.

Comparative custom-house returns, Pascagoula, Miss.

Flag.	Entrances.				Clearances.			
	1884.	1885.	Total No.	Total tons.	1884	1885	Total No.	Total tons.
American	27	35	62	9,166	13	14	27	4,397
Foreign	20	32	52	30,894	23	37	60	33,149
Total	......	......	114	40,060	......	......	87	37,546

List of clearances and statement of lumber shipments from Pascagoula, Miss., June 30, 1885.

Vessels:	
Number	178
Tonnage	8,858
Lumber:	
Superficial feet	39,274,920
Value	$516,914
Timber:	
Cubic feet	2,197,607
Value	$86,907
Custom-house receipts for miscellaneous cargoes	$14,057

Approximate tonnage on Pascagoula River.

Character of vessels.	No.	Tonnage.
Steam tugs	9	250
Schooners, large	15	1,500
Schooners, small	40	800
Barges	18	1,260

P 13.

PRELIMINARY EXAMINATION OF WACISSA RIVER, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., October 21, 1884.

SIR: I have the honor of submitting the following report upon the preliminary examination of Wacissa River, Florida, ordered by circular letter dated July 31, 1884.

In my opinion the river is worthy of improvement, for the following reasons:

The cost of the improvement desired will not exceed $17,000.

There is no present commerce worth mentioning, but it is believed that there would be more than sufficient developed by the improvement to warrant the expenditure of the sum required, as it would furnish a water route for the transportation to a market of large quantities of pine, cypress, and other fine timber, cattle, and grain.

The river is very straight, and runs nearly due south from the fertile hill-country of Jefferson County into the Aucilla, which empties into the Gulf of Mexico, near Saint Mark's.

The work required to effect the improvement is the construction of a short dam and the completion of a canal begun by a private company formed in 1856. The object of the dam is to cut off the water flowing into the Aucilla above the obstruction caused by the lower natural bridge, and the canal to carry the water in a navigable channel into the same river below the obstruction.

No survey will be required, as sufficient information was obtained on the examination for the preparation of a project and estimate of cost of the improvement.

Respectfully submitted.

A. N. DAMRELL,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

EXAMINATION OF WACISSA RIVER, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., January 30, 1886.

SIR: I have the honor of transmitting the report of Mr. R. Rauchenstein, assistant engineer, upon the examination of Wacissa River, Florida.

This river is a tributary of the Aucilla. It rises in Jefferson County, Florida, and flows south in a very direct line through a dense swamp, forming, with the latter, a navigable water-route from near the source to the Gulf of Mexico, about 20½ miles long.

The obstructions to navigation are snags, overhanging trees, aquatic plants, and small shoals.

The improvement of the river so as to give a minimum width of 30 feet and a sufficient depth for boats drawing 2½ feet at ordinary low water would require the removal of the snags, overhanging trees and brush, and aquatic plants, the excavation of rocks and earth at the shoals, and the construction of a dam for training a portion of the water now emptying into the Aucilla above the lower natural bridge (a complete obstruction) on the latter into the same river below it, and a small amount of levee work.

The estimated cost of the improvement is $17,000.

About 2½ miles of the water-route above referred to is a canal, which was opened, by a company formed about 1856, with State aid. About 1880 a new company was formed, under the name of the "Aucilla and Wacissa Navigation Company," which had an examination of the river made, but have done no other work.

The object of the improvement is to provide a short and cheap water-route for the products of the country near the river, which consists now of large amounts of very fine timber, principally pine and cypress, and cattle, in place of the present long and expensive route of about 14 miles over rough hilly roads to the nearest railroad, by the latter to the nearest market.

With an improved river it is possible a large amount of grain would be added to the products that would be transported on it.

The commerce on the river is, at present, very small, hardly worth mentioning. No reliable estimate can be made of the amount that would be developed by the improvement, and although it would probably be sufficient to warrant the comparatively small amount needed, it is still evident that this belongs to that class of works that might well be deferred until those of more importance are completed. Tracings are forwarded as follows:

General index map and sheet showing location of dam, which, together with Mr. Rauchenstein's report, will furnish details of examination and estimate.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. R. RAUCHENSTEIN, ASSISTANT ENGINEER.

MOBILE, ALA., *October* 20, 1884.

SIR: In compliance with instructions contained in your letter dated September 29, 1884, I have the honor to submit the following report upon the examination of Wacissa River, Florida.

The Wacissa River is located in the southern portion of Jefferson County, Florida, between the Saint Mark's and Aucilla rivers, and is a tributary of the latter, emptying its waters into this river about 6 miles above its mouth.

The Wacissa River is formed by a collection of a number of large springs, which rise in the flat pine woodland at the foot of the fertile hill country of Jefferson County. In addition to the springs two small branches, the Mill Branch, from the northwest, and the Little River, from the northeast, supply the river with an additional volume of water at its head.

The Wacissa runs in nearly a straight line due south through an almost impassable swamp from one-half mile wide near the head to 6 or more miles wide at or near its mouth. For about 7 miles the river flows with undiminished volume of water, and only a few small islands are met below this point, and all along its western shore several sloughs or branches, which meander through the widening swamp and debouch into the Aucilla River, diminishing the volume of water in the main river, and numerous islands divide it into several narrower channels. About 7½ miles below the head of the river the Wilaunee or Warrior River flows into the Wacissa from the east, and, in a great measure, replaces the amount of water lost through the branches on the west. The condition of the river remains the same until a distance of 12 miles from its head is reached, where the river is divided into several branches, which empty the main volume of its waters into the Aucilla River above the lower natural bridge, being, therefore, not available for navigation.

To obtain an outlet which would afford navigation to the Gulf a company was formed about 1856, which, with the assistance of State aid, opened a canal, entering the Aucilla below the natural bridges, for the purpose of affording navigation to its mouth.

This canal leaves the Wacissa River on the west side, about 12 miles from its head, just above the point where the river is divided into numerous small branches; and, as the axis of the canal forms a considerable angle with the axis of the river, a dam was constructed by the company across the several outlets, to force a sufficient quantity of water into the canal to obtain a channel 3 feet deep and 30 feet wide.

This work was well planned but badly executed; the dam was constructed of unsuitable material, and, with the exception of a few rocks still remaining, was washed away, while three rock ledges in the lower portion of the canal were only excavated to a depth of 6 inches to 1 foot, thus preventing its use for navigation.

The dam has not been rebuilt, and the canal is choked up with grass and sunken logs, and its banks are overgrown with bushes and small trees overhanging the water.

The river was at the lowest stage at the time of my examination, but nowhere a depth of less than 3½ feet, with a minimum width of 70 feet, was found, affording a sufficient water-way for boats of 2½ feet draught, which could pass through the canal when deepened to 3 feet.

The bottom of the river is lime-rock, covered to various depths with silt, and whenever this occurs (fully two-thirds of its length) the channel is choked up with ribbon-grass, wild rice, saw-grass, and various other aquatic plants, which, with a number of sunken logs and overhanging trees, will require removal to open the channel to navigation.

The extreme rise and fall on the Wacissa is only 18 inches, while the Aucilla during freshets rises several feet, and covers the lower swamps as far as the head of the canal.

In 1880 a new company, under the name of the "Aucilla and Wacissa Navigation and Canal Company," was formed, which, however, has failed so far in accomplishing any results.

Under its direction a thorough reconnaissance of the river and canal was made by Mr. P. W. O. Koerner, civil engineer, and his report, with sketches, was kindly put at my disposal during my examination of the river by Mr. Thomas J. Moore, who accompanied me on my trip to the mouth of the canal, giving me full information as to location of the different points mentioned in said report and needing my special attention.

Based upon all data obtained and verified by my own observations, I submit the following approximate estimate of cost of improving Wacissa River to make it navigable for boats drawing 2½ feet at ordinary low water:

Removing sunken logs, overhanging trees, grass, &c., opening a clear channel-way 50 feet wide down Wacissa River, Florida, 12 miles, at $150 per mile....	$1,800
Cutting overhanging trees and clearing banks of canal for 12 feet on each side and cleaning out grass, 2½ miles, at $280 per mile..................	700
1,050 cubic yards rock excavation in canal, at $5 per cubic yard............	5,250
1,200 yards earth excavation in canal, at 50 cents per yard................	600
650 cubic yards levee on canal, at 30 cents per cubic yard................	195
600 cubic yards rock put in main dam, including necessary cribbing, at $4 ..	2,400
Boat with steam hoist and outfit..	4,500
Engineering expenses and contingencies	1,555
Total..	17,000

In this estimate I calculated the rock-dam to be raised to height of the medium stage of the water in the river, which, however, may not become necessary after the canal has been cleared of all its obstructions and a further reduction in the cost of this dam may occur by using the rock excavated from the shoals in the canal for its construction.

I have endeavored, with the data furnished me, as above stated, and my own observations, soundings, &c., to make this estimate complete and reliable, so as to make any further survey or examination unnecessary until actual work should begin.

There is at present no commerce carried on on this river. A few small boats pushed by pole through the grass carry fish from the mouth of the Aucilla to the head of the Wacissa, whence they are distributed through the up-country and find ready sale.

As to the probable amount of commerce which would be developed by the opening of this river I submit the following information, obtained from parties living in the vicinity and interested in the improvement:

The main object in making this river navigable is to open a market for pine, cypress, and other timber.

The pine belt tributary to this outlet extends for miles east and west from the head of the river, with a varying width of from 2 to 6 miles, and, as the distance to the nearest railroad is about 14 miles, over hilly roads, a water-way affording cheap transportation is the object desired.

There are also a large number of cattle raised through this entire pine-wood country, which are principally sold for export to Havana, and have to be carried by rail to Tampa at great loss and expense. With water transportation these cattle could be carried to Cedar Keys or Saint Mark's at a comparatively small expense and shipped hence direct to Havana.

I am also informed that a large surplus of grain is or could be raised in the country adjoining the timber belt on the north, said to contain the most fertile lands in Jefferson County, and the whole Gulf coast of South Florida could be suppled with corn from this source. If cheap water transportation could be obtained numerous other farm products would probably seek the same market.

Respectfully submitted.

R. RAUCHENSTEIN,
Assistant Engineer.

Maj. A. N. DAMRELL,
Corps of Engineers, U. S. A.

APPENDIX Q.

INSPECTION OF THE IMPROVEMENT AT THE SOUTH PASS OF THE MISSISSIPPI RIVER.

REPORT OF MAJOR W. H. HEUER, CORPS OF ENGINEERS, INSPECTING OFFICER, FOR THE FISCAL YEAR ENDING JUNE 30, 1886.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., July 8, 1886.

GENERAL: I have the honor to submit my report for the fiscal year ending June 30, 1886, upon the improvement of South Pass of the Mississippi River.

The following charts accompany this report:

No. 1.—Chart of channel from opposite South Pass light-house to deeper water in the Gulf.
No. 2.—Chart of a part of the Gulf of Mexico, showing depths out to that of 100 feet.
No. 3.—Chart of South Pass, from South Pass light-house to Bayou Grande.
No. 4.—Chart of South Pass, from Bayou Grande to Head of Passes.
No. 5.—Chart of the Head of the Passes.
No. 6.—Plan and comparative profiles of South Pass.
No. 7.—Miscellaneous sections, profiles, curves, &c.
Plate I.—Diagrams explaining changes in the Gulf from 1877 to 1886.

Most of the subject-matter of this report is presented in such a manner on the above-mentioned charts and in tabular form, also by diagrams, throughout the report, that very little of a descriptive character is required. The methods of presenting results and making comparisons with earlier results, which have been followed for years, are still adhered to, and when understood they will be found very interesting.

AT THE HEAD OF THE PASSES AND IN SOUTH PASS.

No work has been done at the Head of the Passes since July, 1879, nor in the pass itself since November, 1883. All the dikes, dams, &c., comprising these structures are submerged, and the greater portion of them buried by sedimentary deposits. The piling which is above the surface of the water is badly decayed and is gradually disappearing; this, however, is of no importance since the mattresses are now secured by deposits upon them, and the works still maintain the channel created by them. The condition of these works and of the mattress-sills across Northeast and Southwest Passes has not changed materially during the year.

AT THE MOUTH OF SOUTH PASS.

The condition of the main jetties has not changed during the year, and no work has been done upon them. In fact, it is probable that nothing more will ever be done on the original jetties.

The east jetty is completely buried by deposits for a length of 5,000 feet from East Point; the next 1,300 feet has its upper surface about average flood tide; it is well ballasted with stone, and the water on either side of it being very shoal it remains permanent. It is also protected by the cribs on the sea-side of the jetty 6,300 feet below East Point. The 3,040 feet in length of masonry which was more or less injured by the storms of September 9, 1882, still acts as an effective barrier to the heavy seas, and therefore protects the inner jetty, which maintains the channel.

The masonry on the remainder of this jetty is in good condition and averages about 4 feet above average flood tide. During the year the average subsidence of this masonry was 0.13 feet, and for six years it is 1.35 feet.

West jetty.—Four thousand eight hundred feet of this jetty is buried by deposits, and throughout the remainder of its length it is capped with concrete blocks, which are in good condition and average about 1 foot above average flood tide except on the outer 300 feet, where they are two tenths of a foot below that plane. During the year the average settlement of these (154) blocks was one-tenth of a foot, andfor seven years it is 1.6 feet.

The rapid accumulation of sediment on the sea-side of this jetty renders it very permanent.

INNER EAST JETTY.

This jetty is shown on Chart No. 1; each of the parallel lines represent a row of piles, and between these rows willows ballasted with stone are placed. From time to time during the year willows and stone have been placed in this jetty, at localities where it had settled below the surface of the water, and at some points where it was found that a scouring was taking place under the jetty the willows were placed in such a way as to increase the width of the jetty and prevent such action.

At present this jetty is in fair condition, and from 1 to 5 feet above average flood tide. In its maintenance during the year the following materials were used, viz, 2,883 cords of willows, and 1,035 cubic yards of stone.

INNER WEST JETTY.

During the month of February work was commenced on the inner west jetty, which begins at △C, or at a point 7,000 feet below East Point. The objects of this jetty are, first, to prevent the escape of water at flood tide over the concrete blocks on the west jetty; second, to prevent the material which has accumulated between the wing-dams from being drawn into the channel by the swash produced by passing vessels; and, thirdly, to contract the water-way and increase the scour-power of the current.

This jetty has the general direction of the west jetty, is about 150 feet from it, and is parallel to and 675 feet from the inner east jetty. Throughout most of its length it is built in about 2 feet of water, and consists of 1, 2, 3, 4 and 5 rows of piles (as represented on Chart No. 1), according to the locality. The rows of piles are 8 feet apart, and the piles in each row are about the same distance apart; between the piles willows are placed and ballasted with stone. Where there is but one row of piles the willows are placed so as to make the top of the jetty about 15 feet wide, and sufficient stone to prevent them from floating placed upon them. The piles in the two rows nearest the channel, and below Wing-dam 15, are creosoted. This jetty is partially completed, except about 300 feet; that is, willows and stone sufficient to check the flow of water over the west jetty have been placed in it. In its construction the following materials were used, viz: 1,192 piles (106 of which are creosoted), 3,505 cords of willows, and 1,252 cubic yards of stone.

In connection with and for the same purpose as the inner west jetty was built, a row of piles was driven between Wing-dams 27 and 29; parallel to the west jetty and 10 feet from a row of piles which formerly supported a railway over the west jetty, willows were then placed between these two rows of piles and ballasted with stone. The length of this structure is 240 feet, and in it 29 piles, 296 cords of willows, and 70 cubic yards of stone were used.

WING-DAMS.

In February, Wing-dam No. 27 was built, projecting from the west jetty 300 feet above the end. This was for the purpose of correcting a shoaling which had taken place in the channel opposite this point.

This dam is 153 feet long and consists of 3 rows of piles 11 feet apart, the piles in each row being 8 feet apart, those in the lower row being connected together by 12 by 12 inch timbers, drift-bolted to them near their tops. The spaces between the piles are then filled with willows, which are ballasted with stone. In the construction of this dam the following materials were used, viz: 57 piles, 681 cords of willows, 186 cubic yards of stone, 140 linear feet of 12 by 12 inch timber, and 17 drift-bolts.

Dam No. 28 connects the upper end of the inner west jetty with the main jetty; it is 130 feet long, 12 feet wide, and consists of willows confined between two rows of stakes and ballasted with stone. The material used in this dam is included in the amount used in the inner west jetty.

Dam No. 29 connects the sea-end of the west jetty with that of the inner west jetty, it is 136 feet long, 37 feet wide, and contains 5 rows of piles, two of which are 12 feet apart and the other 8 feet apart. The piles in each row are about 8 feet apart, and those in the two outer rows are creosoted.

The spaces between the piles are filled with willows, which are ballasted with stone. The following materials were used in this dam, viz: 83 piles, 624 cords of willows, and 370 cubic yards of stone.

Dams Nos. 9, 10, 11 and 15, all auxiliary to the west jetty, have had their channel-ends rebuilt or repaired by the addition of the following materials, viz: 70 piles, 207 linear feet of 12 by 12 inch timber, 545 cords of willows, 141 cubic yards of stone, and 93 feet of $\frac{3}{4}$-inch chain.

The dam connecting the sea-end of the east jetty with that of the inner east jetty had 68 cords of willows and 232 cubic yards of stone added to it during the year, and is in good condition.

The longitudinal dam or T-head of piles and lattice-work, which was built in 1881, connecting the outer ends of Dams No. 1 and 2 is gradually disappearing, having become badly decayed.

DREDGING.

No dredging has been done at any locality since February 22, 1883.

THE PLANT.

During the year three steel barges, the dredge-boat, and a derrick-boat were repaired, a pair of ways built, and fifty-two mooring-piles driven at different points.

FORCE EMPLOYED.

The average force employed during the year, including officers, mechanics, and laborers, was 34 in number.

EXAMINATIONS AND SURVEYS.

The results of examinations and surveys made during the year were reported monthly, and these, together with earlier results, and also those deduced from the latest and more extended surveys, will be found in this report, and they are so compiled that, by studying the graphical representations and tabulated statements, one may gain detailed information concerning the present channels, the changes which have taken place, &c.

The results of tidal, sediment, and velocity observations are given on chart No. 7, and fully explained thereon.

AT THE HEAD OF THE PASSES.

The chart of this survey is No. 5, and on chart No. 7 will be found comparative profiles and sections which furnish information regarding the changes which have occurred during the year and since 1875.

On account of the width of section at this locality, where the river divides into three passes, its depth varies with the stage of the river; that is, the depth is greatest in high river and least during low river.

Using sections G H and I J, chart No. 7, it will be seen that the shoaling which took place above Upper Dam last year has been greatly reduced, and that now the tendency of the shoaling above this dam is to the westward, whereas last year it extended towards and well into Northeast Pass.

Comparative profiles E F show that the depth into Northeast Pass has increased an amount varying from 2 to 5 feet, in vertical height, above the mattress-sill and 9 feet below it during the year, and from 4 to 10 feet since 1875.

Profiles A B show that but little change has taken place during the year, or since 1875, in the entrance to South Pass above a point 1,000 feet above Upper Dam. Below that point it has deepened in some places and shoaled in others during the year. The great deepening which has taken place in the entrance to this pass since 1875 will be readily seen from these profiles.

Profiles C D show that Southwest Pass has deepened quite uniformly about 1.5 feet down to a point opposite Upper Dam, below which there has been but little change, and since 1875 this pass has deepened about 2 feet down to the mattress-sill.

From the above, therefore, we find that there has been a deepening during the year and since 1875, and again we note the fact that while the entrance to South Pass has been greatly deepened, those into the other passes have, in comparison, been but little changed.

On June 21 the least depth from the main river into South Pass was 32.4 feet, and the 30-foot channel was very wide.

SURVEY OF SOUTH PASS FROM ITS HEAD TO SOUTH PASS LIGHT-HOUSE.

During the month of November a complete survey of South Pass was made, the charts of which are Nos. 3 and 4.

As compared with a similar survey made during the same month of the year previous, there has been a deepening in the pass. The greatest deepening took place in the deeper reaches while the shoaler ones in some cases shoaled and in others remained unchanged.

Picayune Bayou, Grand Bayou, and Goat Island reaches all shoaled, but since the river began to rise in January they have deepened again.

Since 1875 there has been a decided shoaling throughout the pass, as will be seen from an inspection of the comparative profiles on chart No. 6. These profiles give a complete record of the changes in the channel from the main river, throughout South Pass, and through the jetties, to the Gulf, and will be found interesting.

On June 21 the least depth in the pass was in the reach above Goat Island, which had a central depth of 29.8 feet, and the 26-foot channel was 300 feet wide.

On the same day there was a central depth of 30 feet in Grand Bayou and Picayune Bayou reaches.

At other localities throughout the pass the depth and width of channel is substantially as shown on charts 3 and 4, from which the following table was compiled:

Tabulated statement of the depth and width of channel throughout South Pass of the Mississippi River, from East Point to 30-foot depth in the main river, given in separate reaches, one-fourth of a mile in length, from a survey made in November, 1885.

From—	To above East Point.	Least available depth.	Least width for 26-foot depth.	Least width for 30-foot depth.	From—	To above East Point.	Least available depth.	Least width for 26-foot depth.	Least width for 30-foot depth.
East Point	¼ mile	30.1	310	30	Above East Point:				
Above East Point:					4 miles	4¼ miles	36.6	400	310
¼ mile	½ mile	30.1	410	130	4¼ miles	4½ miles	34.8	450	340
½ mile	¾ mile	32.1	350	200	4½ miles	4¾ miles	37.6	440	330
¾ mile	1 mile	34.0	310	180	4¾ miles	5 miles	37.5	360	220
First mile	....	30.1	310	30	Fifth mile	....	34.8	360	220
1 mile	1¼ miles	31.8	340	150	5 miles	5¼ miles	29.7	340	(3)
1¼ miles	1½ miles	30.7	380	70	5¼ miles	5½ miles	29.6	470	(4)
1½ miles	1¾ miles	28.4	440	(1)	5½ miles	5¾ miles	28.5	310	(5)
1¾ miles	2 miles	28.8	430	(2)	5¾ miles	6 miles	29.1	300	(6)
Second mile	....	28.4	340	......	Sixth mile	....	28.5	300	......
2 miles	2¼ miles	31.4	450	340	6 miles	6¼ miles	29.4	400	(7)
2¼ miles	2½ miles	35.4	430	390	6¼ miles	6½ miles	30.4	420	130
2½ miles	2¾ miles	37.3	420	380	6½ miles	6¾ miles	33.4	400	300
2¾ miles	3 miles	36.2	430	380	6¾ miles	7 miles	35.5	400	300
Third mile	....	31.4	420	340	Seventh mile	....	29.4	400	130
3 miles	3¼ miles	35.2	410	300	7 miles,	7¼ miles	33.5	480	270
3¼ miles	3½ miles	32.1	410	230	7¼ miles	7½ miles	32.5	450	310
3½ miles	3¾ miles	30.7	420	230	7½ miles	7¾ miles	38.6	340	290
3¾ miles	4 miles	34.0	410	290	7¾ miles	8 miles	43.5	340	270
Fourth mile	....	30.7	410	230	Eighth mile	....	32.5	340	270

Tabulated statement of the depth and width of channel throughout South Pass of the Mississippi River, &c.—Continued.

From—	To above East Point.	Least available depth.	Least width for 26-foot depth.	Least width for 30-foot depth.	From—	To above East Point.	Least available depth.	Least width for 26-foot depth.	Least width for 30-foot depth.
Above East Point:					Above East Point:				
8 miles	8¼ miles	37.4	360	270	10 miles	10¼ miles	40.4	300	270
8¼ miles	8½ miles	35.5	380	260	10¼ miles	10½ miles	40.0	330	270
8½ miles	8¾ miles	34.4	270	300	10½ miles	10¾ miles	40.5	330	260
8¾ miles	9 miles	36.4	250	180	10¾ miles	11 miles	33.6	400	250
Ninth mile	....	34.4	250	180	Eleventh mile	....	33.6	300	260
9 miles	9¼ miles	34.2	250	150	11 miles	11¼ miles	40.4	(*)	720
9¼ miles	9½ miles	28.2	370	(8)	11¼ miles	11½ miles	28.8	(*)	(9)
9½ miles	9¾ miles	31.1	380	260	11½ miles	11¾ miles	27.8	(*)	(10)
9¾ miles	10 miles	47.3	380	290	11¾ miles	12 miles	†30	......	......
Tenth mile	....	28.2	250	......	Twelfth mile	....			

*Very wide. †In Mississippi River above Head of Passes.

Length of the portion of this reach lacking a central depth of 30 feet.

	Feet.		Feet.		Feet.
(1)	1,180	(5)	800	(9)	750
(2)	340	(6)	420	(10)	900
(3)	200	(7)	390		
(4)	470	(8)	700	Total length of channel	6,160

THE CHANNEL THROUGH THE JETTIES.

The channel through the jetties is shown on Chart No. 1. As compared with a survey made one year ago, this channel has deepened during the year, and particularly below where the inner west jetty begins. In places the depth has increased 14 feet, the average deepening being about 5 feet.

During the months of September, October, November, December, and January this channel shoaled throughout, in consequence of the sediment brought down by those short crises which occurred during those months. Had the river continued to rise, the current would have been increased sufficiently to have carried the sediment into the Gulf, but, after rising about 4 feet it would then fall about the same amount, the current would be decreased in velocity, and the sediment deposited. There was sufficient margin over the required depth, so that the channel did not shoal to less than that depth, except between the ends of the jetties, where for seventeen days (from January 25 to 29, inclusive, and from February 5 to 16 inclusive) the required channel did not obtain.

At the time this deficiency occurred the concrete blocks on the west jetty, opposite to where the shoaling took place, were submerged at flood tide, and therefore the flood water was not concentrated in the channel; on the contrary, the flood-tide cross-section was greatly increased, and, combined with the effect of the fluctuations in the stage of the river, as a natural consequence, caused a shoaling.

The changes which have taken place in the depth and width of the jetty channel from month to month during the year will be seen from the following table:

Tabulated statements regarding the minimum depths and widths of channel through the jetties, in separate reaches of 2,000 feet each, according to surveys made monthly during the fiscal year ending June 30, 1886.

DISTANCE FROM EAST POINT.

Date.	0 to 2,000 feet.			2,000 to 4,000 feet.			4,000 to 6,000 feet.		
	Least depth.	Least width for—		Least depth.	Least width for—		Least depth.	Least width for—	
		26 feet depth.	30 feet depth.		26 feet depth.	30 feet depth.		29 feet depth.	30 feet depth.
1885.									
June	34.7	330	190	33.7	340	300	35.7	360	270
July	36.3	330	200	33.1	350	290	36.5	370	290
August	36.5	340	180	35.6	360	310	37.6	370	300
September	35.3	330	170	33.3	350	300	35.2	380	360
October	33.8	310	170	33.7	360	310	35.8	350	280
November	32.7	280	160	32.8	330	280	35.1	360	260
December	33.0	300	160	32.2	330	260	34.2	360	220
1886.									
January	33.6	290	140	32.5	320	250	33.0	340	200
February	32.8	320	190	32.8	350	310	34.1	350	240
March	32.8	310	170	35.8	330	280	34.0	360	220
April	35.4	310	180	34.5	350	280	34.5	340	280
May	35.9	330	210	35.6	360	300	34.2	370	220
June	33.2	350	200	35.2	370	300	33.4	380	280

Date.	6,000 to 8,000 feet.			8,000 to 10,000 feet.			10,000 to 12,000 feet.		
	Least depth.	Least width for—		Least depth.	Least width for—		Least depth.	Least width for—	
		26 feet depth.	30 feet depth.		29 feet depth.	30 feet depth.		26 feet depth.	30 feet depth.
1885.									
June	32.8	270	160	32.8	280	130	31.3	270	130
July	33.7	300	180	33.6	330	150	31.0	310	130
August	33.0	320	170	32.0	290	130	31.0	280	110
September	32.2	300	170	30.7	260	110	31.7	240	110
October	31.3	270	120	30.4	230	90	30.4	210	60
November	30.8	250	100	30.6	230	90	30.1	220	30
December	30.9	220	90	30.5	220	50	30.6	210	30
1886.									
January	30.2	220	40	30.2	185	40	28.5	185	....
February	31.3	225	100	30.9	230	65	30.0	200	45
March	35.0	230	130	33.1	240	180	32.0	280	130
April	33.7	230	150	33.7	240	200	31.0	270	100
May	31.0	270	180	36.0	300	220	34.5	360	210
June	33.2	240	170	34.5	320	240	36.5	330	240

The least depth at any point in a channel is the most important, and therefore in these statements only that depth is given. By reference to the profile on Chart No. 6 one may know the depth of water at every point throughout this channel, and it will be seen that but a comparatively short reach in it has a less depth than 35 feet.

According to the above table the least depth through the jetties at present is 33.2 feet; the least width of the 26-foot channel is 240 feet, and of the 30-foot channel 170 feet.

Beyond the ends of the jetties there is a central depth of 31.2 feet, and the 26 and 30 foot channels are, respectively, 260 and 190 feet wide.

The following table gives the minimum depths of channel through the jetties at various dates since the commencement of the works of improvement, and serves to show the progressive channel improvement from that time to the present.

Table giving the depths of water through the jetties at various dates.

Date.	Distances from East Point, in feet.					
	0 to 2,000	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1875.						
June	22.5	18.7	16.7	10.2	9.7	9.2
1876.						
May	23.3	20.3	22.0	21.0	17.1	15.0
August	23.5	19.6	21.0	23.5	23.0	19.8
November	22.0	20.3	21.1	21.2	21.1	20.3
1877.						
March	24.1	21.1	23.2	22.0	21.2	20.5
July	24.9	24.0	26.0	23.8	23.5	20.3
October 25 to December 14	26.3	24.4	28.5	24.2	23.0	23.7
1878.						
March	26.0	25.9	35.5	25.4	24.3	23.0
December	28.4	26.4	35.7	27.1	25.3	23.0
1879.						
March	28.6	27.5	43.4	27.0	27.0	27.0
June	27.5	28.4	47.7	29.2	29.2	28.0
July 8	30.5	30.7	....	31.0	30.7	30.5
December	31.0	31.0	48.3	31.7	31.8	30.8
1880.						
June	31.0	32.5	47.8	31.4	35.1	32.0
July	30.5	31.0	44.0	30.8	31.5	30.5
August	30.5	30.4	46.0	32.0	32.0	30.5
September	30.7	31.0	44.4	30.6	32.0	31.0
October	31.0	31.5	41.0	30.3	31.0	30.5
November	30.6	31.0	40.8	30.8	30.9	30.5
December	30.9	30.6	43.0	30.8	31.0	30.3
1881.						
January	30.5	30.4	41.9	33.8	30.7	30.3
February	30.4	30.2	41.6	32.0	31.0	30.0
March	31.5	31.2	41.3	32.0	32.0	30.5
April	30.4	30.0	43.0	33.0	33.0	30.5
May	30.2	30.5	42.7	32.6	30.5	31.3
June	30.0	30.5	43.8	32.0	31.7	31.7
July	31.0	32.0	42.5	33.5	33.0	32.0
August	30.1	32.0	37.6	32.0	31.0	30.3
October	30.2	30.3	38.3	31.4	31.2	30.3
November	30.8	31.8	39.2	30.4	30.0	30.1
December	30.2	32.8	39.4	30.8	30.2	30.0
1882.						
January	30.5	30.4	41.8	31.1	30.2	30.7
February	31.8	36.0	39.7	30.5	30.8	30.2
March	31.2	30.6	39.2	30.8	31.6	32.5
April	31.7	32.6	39.6	30.5	30.3	33.0
May	30.5	32.5	39.4	31.0	31.3	31.0
June	30.8	35.5	39.0	31.2	31.3	31.0
July	30.0	32.7	38.7	30.6	31.3	31.5
August	30.8	32.2	38.1	31.8	31.8	30.5
September	30.1	31.5	38.3	31.9	30.8	30.5
October	30.0	31.0	37.1	31.0	31.4	31.2
November	30.0	32.0	38.1	21.5	31.2	31.2
December	31.0	31.0	37.0	31.2	31.0	30.4
1883.						
January	31.0	31.0	35.2	30.2	30.1	30.1
February	31.2	31.2	36.0	30.5	30.0	30.1
March	32.8	32.6	45.7	31.5	30.3	30.3
April	33.7	35.0	44.0	32.2	30.0	32.0
May	33.2	36.3	46.0	32.3	30.3	32.4
June	32.5	34.2	45.0	33.4	31.0	33.0
July	33.8	34.9	44.0	32.0	31.5	31.8
August	32.1	33.2	48.0	33.4	33.4	32.2
September	33.4	34.3	46.0	32.3	32.3	30.6
October	32.7	34.1	41.5	32.0	32.0	30.5
November	31.0	33.8	43.8	34.5	31.5	31.0
December	30.5	32.6	43.0	31.6	31.6	30.2
1884.						
January	31.2	32.2	39.2	32.7	31.8	30.3
February	32.0	31.5	41.3	31.6	31.0	30.7

Table giving the depths of water through the jetties at various dates—Continued.

Date.	Distance from East Point, in feet.					
	0 to 2,000	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1884.						
March	35.7	39.5	41.6	34.0	33.8	38.7
April	35.3	37.3	41.5	31.7	32.7	35.4
May	34.9	35.8	42.3	34.3	35.1	33.0
June	35.0	35.8	41.1	34.0	35.0	35.0
August	31.9	35.8	41.9	33.9	35.0	32.0
September	32.0	34.0	39.0	33.1	33.7	38.5
October	31.1	33.4	38.6	32.6	32.6	32.5
November	32.8	32.8	37.2	32.2	32.4	30.8
December	31.6	32.6	37.1	31.1	31.5	31.4
1885.						
January	36.7	36.4	36.9	33.1	34.6	32.8
February	41.7	36.8	35.7	30.5	34.1	36.2
March	35.5	36.0	36.1	31.0	31.7	35.7
April	36.0	35.5	37.0	32.0	32.6	32.0
May	36.7	35.0	35.6	31.5	33.5	31.5
June	34.7	33.7	35.7	32.8	32.8	31.3
July	36.3	33.1	36.5	33.7	33.6	31.0
August	36.5	35.6	37.0	33.0	32.0	31.0
September	35.3	33.8	35.2	32.2	30.7	31.7
October	33.8	33.7	35.8	31.3	30.4	30.4
November	32.7	32.8	35.1	30.8	30.6	30.1
December	33.0	32.2	34.2	30.9	30.5	30.6
1886.						
January	33.6	32.5	33.0	30.2	30.2	28.5
February	32.8	32.8	34.1	31.3	30.9	30.0
March	32.8	35.8	34.0	35.0	33.1	32.0
April	35.4	34.5	34.5	33.7	33.7	31.0
May	35.9	35.6	34.2	31.0	30.0	34.4
June	38.2	35.2	33.4	33.2	34.5	36.5

SURVEY BEYOND THE ENDS OF THE JETTIES.

The chart of this survey is No. 2. The survey extends to a depth of 100 feet of water, which is about 1½ miles beyond the ends of the jetties.

By reference to Plate I, the note on which fully explains the results thereon, it will be seen that the 20, 30, 40, and 50 feet curves advanced during the year, and that all the crest receded, the 60-foot curve showing but little change. These results are exactly the reverse of those obtained last year, and show that whatever shoaling has taken place during the year has been in a lesser depth than 60 feet of water.

The following diagram gives the amount that each curve has advanced since 1877. Taking the results in 1877 as a basis for comparison, the amount that each curve has advanced since then will be the difference between its mean ordinate for 1877 and that for 1886. For example, we see that from 1877 to 1886 the 70-foot curve advanced 899 feet, &c. This curve shows the greatest advance, and the 20-foot curve shows the least.

As heretofore shown, and as a well-established fact, the curves of lesser depths show the greatest advance on the westward and the least on the eastward, while generally the central portion advances the least. From an examination of Chart No. 2 it will be seen that but two of the curves which show a recession are within the area which is compared by mean depths, and since the majority of the curves within that area shows an advance, it indicates that the general result will be a shoaling.

This area contains 1¼ square miles, and is subdivided into 21 lesser areas. The mean depth of each and then of the whole area is determined and compared with earlier results similarly obtained, and in this way we may locate the areas which are undergoing the greatest or least change—that is, we may show how the material deposited is distributed over this area.

The results of these determinations are as follows, viz:

	Feet.
Mean fill over whole area from 1885 to 1886	0.12
Mean fill over whole area from 1876 to 1886	7.25

A clear understanding of the change in each subdivision of this area will be readily obtained from the following diagrams, which represent it on a small scale.

The figures in each subdivision are the differences between the mean depths of each division as obtained for the years between which the comparisons are made, and therefore express in feet and tenths of a foot the vertical height of the deepening or shoaling in each.

Shaded areas are those which have shoaled, and blank areas have deepened.

No. 1 gives the results obtained by comparing the depths for 1885 with those for 1886, and No. 2 compares those for 1876 with those for 1886.

The results on No. 2 confirm those deduced in the comparisons by mean ordinates, and likewise show that the greatest shoaling westward of a line which is the prolongation of the west jetty is near the end of that jetty, while to the eastward of a line, which is the prolongation of the last jetty the shoaling is greatest in the division most remote from the end of that jetty; and, finally, that the central areas, or those directly in advance of the jetties, have shoaled the least.

RECAPITULATION.

From the preceding results it will be seen that the least depth at any point throughout the channel from the main river to the Gulf of Mexico is 29.8 feet, and the least width of the 26-foot channel is 240 feet.

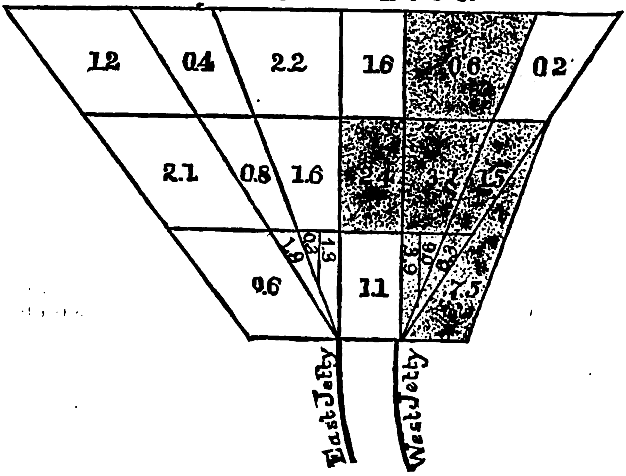
Since August 1, 1882, with the exception of seventeen days previously mentioned, there has been "a channel through the jetties 26 feet in depth, not less than 200 feet in width at the bottom, and having through it a central depth of 30 feet without regard to width;" also through the shoal at the head of South Pass, and "through the Pass itself," there has been "a channel having a navigable depth of 26 feet."

VESSELS AGROUND.

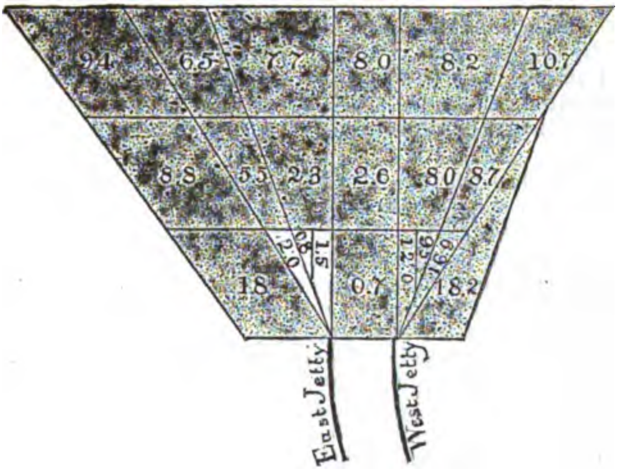
But three vessels were aground during the year, one near the foot of Crane Island, and two on the lump beyond the ends of the jetties, which is now marked by a spar-buoy. One of these vessels was drawing 24.5 feet. In each case it was stated that the vessels "handled badly."

The depth of water in the channel was measured as soon as the vessel grounded, and the fact established that it was not for want of depth of water that these accidents occurred.

No. 1. 1885 to 1886.



No. 2. 1876. to 1886.



ESTIMATE OF FUNDS REQUIRED FOR EXAMINATIONS AND SURVEYS AT SOUTH PASS OF THE MISSISSIPPI RIVER FOR THE FISCAL YEAR ENDING JUNE 30, 1888.

2 assistant engineers	$4,500
1 recorder	1,200
1 steam engineer	1,200
1 water-level observer	120
5 seamen	4,680
Rent of office	180
Rent of assistant engineers' quarters	240
Mileage and traveling expenses	200
Fuel for launch and office	350

Repairs to launches and boats	$1,200
Supplies for launches and office	500
Contingencies	2,500
Total	16,870

Money statement.

July 1, 1885, amount available		$3,849 44
Amount appropriated by act approved May 26, 1886, to supply deficiency in amount required for expenditure to June 30, 1886		6,492 00
		10,341 44
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$9,119 92	
July 1, 1886, outstanding liabilities	49 02	
		9,168 94
July 1, 1886, amount available		1,172 5
Amount that can be profitably expended in fiscal year ending June 30, 1888		16,870 0

CONCLUSION.

The duty which involves upon me as inspecting officer of the jettie is such as to require that I keep a party employed at Port Eads, i order that I may be prepared "to report the depth of water and widt of channel secured and maintained from time to time in said channel together with such other information as the Secretary of War may direct."

On December 1, 1875, the available funds for this work were exhausted, and as I am prohibited by law from incurring any obligations beyond appropriations made, I was unable to ask or request m party of employés to continue their services after that date. They however, voluntarily continued their services, relieving the Governme from any obligation to pay them for the same, unless Congress voluntarily appropriated funds for that purpose.

They continued their services seven months before receiving any remuneration, and for the information furnished during that time, an for the subject-matter of this report, all of which is of importance t commerce and the Government, I am indebted to them.

In view of the fact that Mr. Eads may claim his quarterly payment whether examinations and surveys are made or not, and in view of th commercial importance of this work, and of the interest which the Government has involved, and again that the series of valuable resul deduced from these surveys may not be interrupted, I would respectfully suggest that the appropriation for this work be made an independent measure, as is the appropriation from which the contractor i paid.

I would again respectfully invite attention to the importance and necessity of authorizing the enforcement of rules regulating the navigati of South Pass, and also of driving mooring piles along the east bank o the pass.

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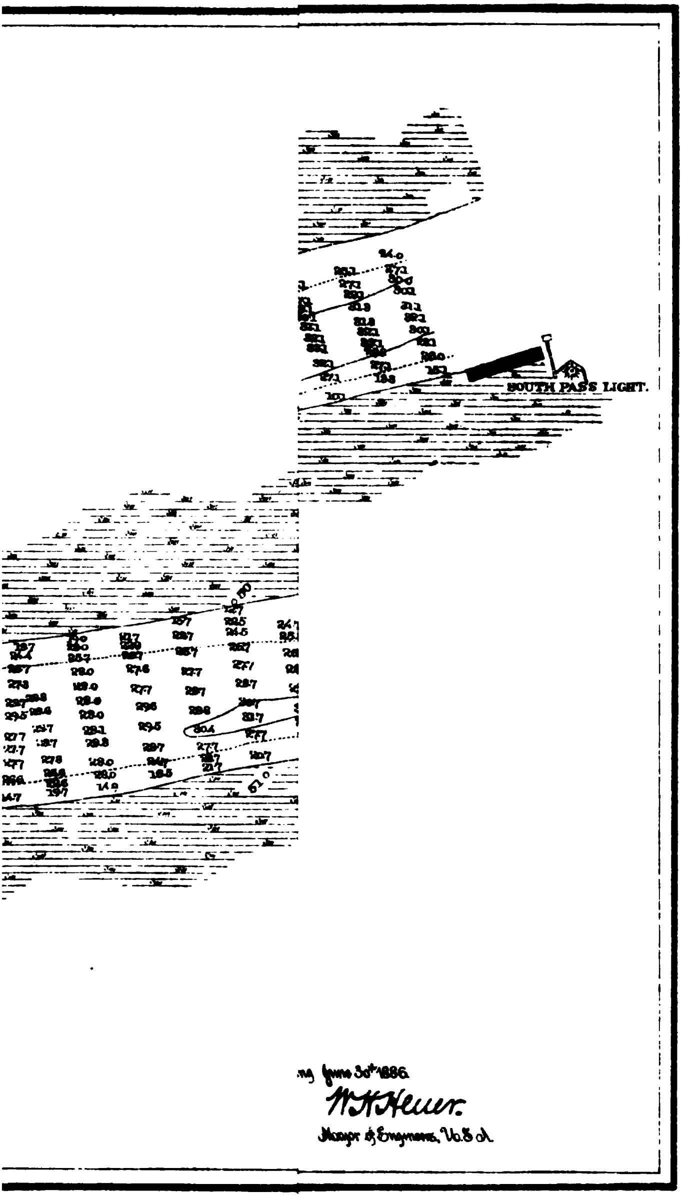
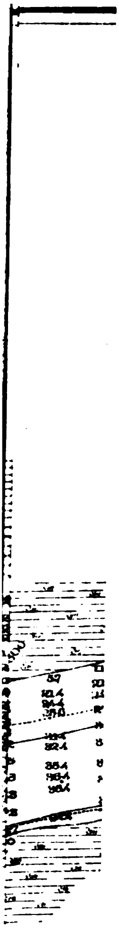


ng June 30th 1886.

W. H. Heuer.

Major of Engineers, U.S.A.

THE AMERICAN GRAPHIC CO., N.Y.



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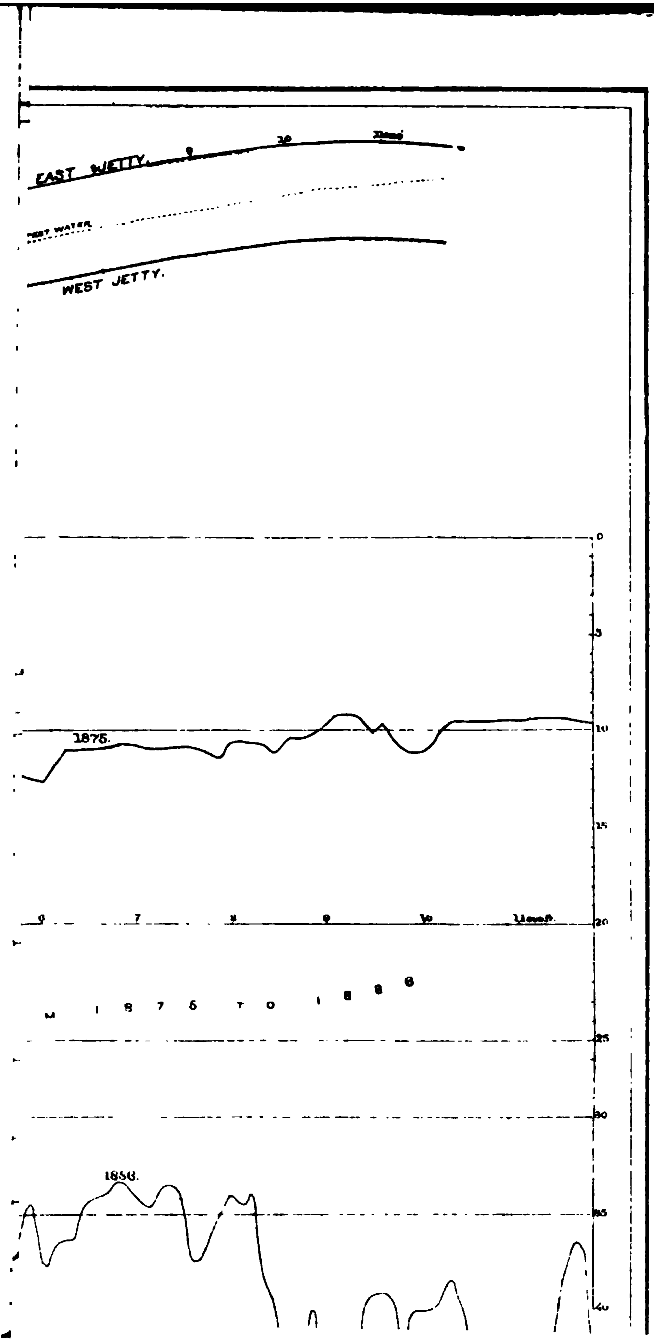
EAST JETTY.
9
10
WEST JETTY.
1875.
0
5
10
15
20
25
30
35
40
6
7
8
9
10
M 1875 TO 1886
1856.

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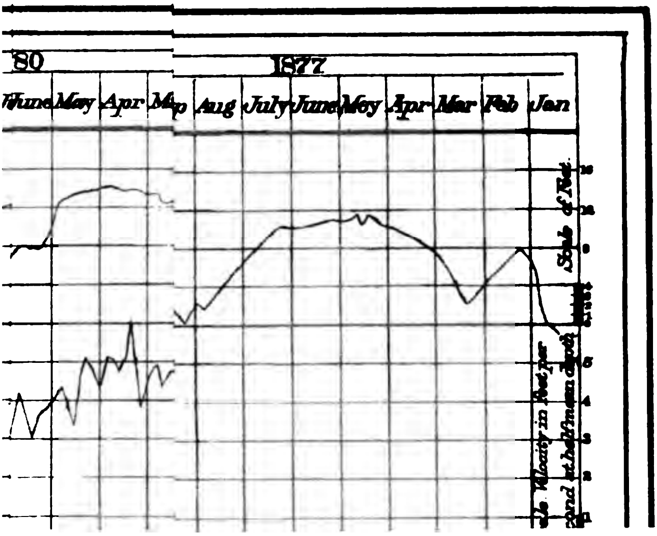
7


80
1877
June
May
Apr
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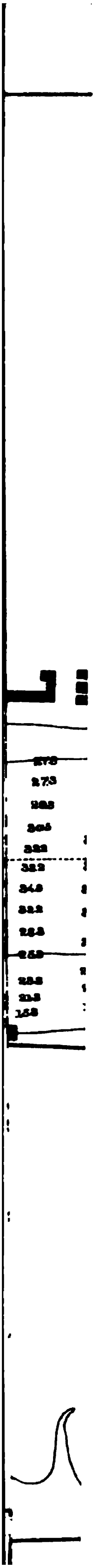
p
Aug
July
June
May
Apr
Mar
Feb
Jan
Scale of Feet
Velocity in feet per
second at half mean depth
16
12
8
6
4
3
2
1

8



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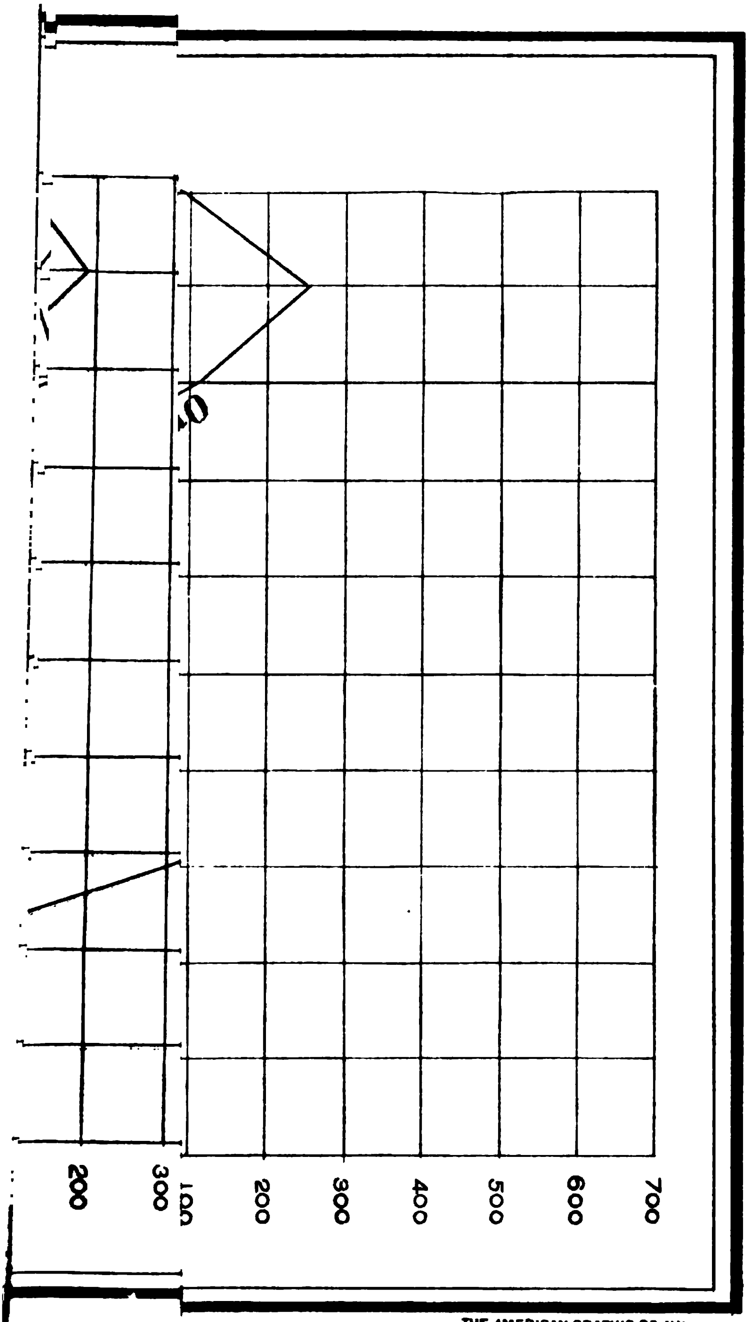
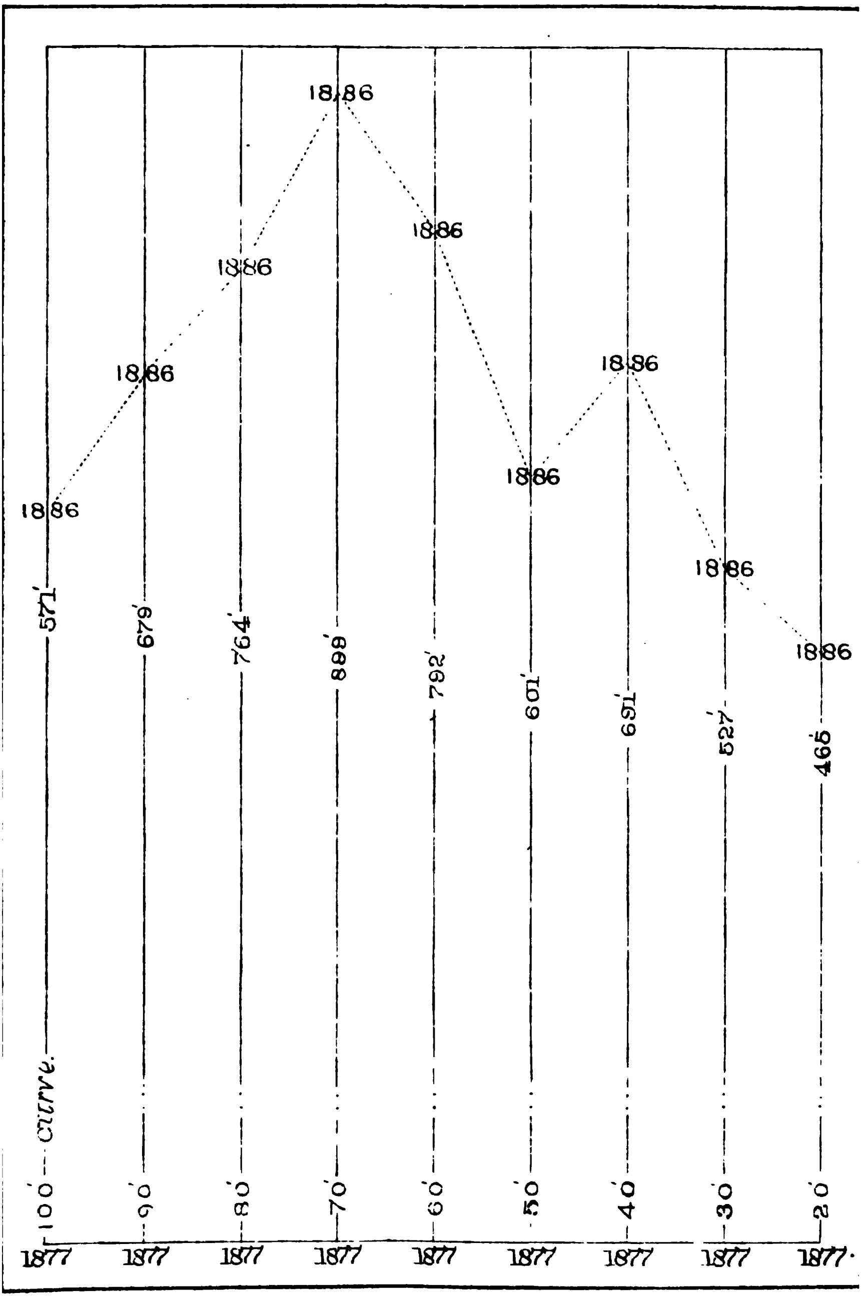


THE AMERICAN GRAPHIC CO., N.Y.


1886
1886
1886
1886
1886
1886
1886
1886
1886
571'
679'
764'
889'
792'
601'
691'
527'
465
100'
90'
80'
70'
60'
50'
40'
30'
20'
curve.
1877
1877
1877
1877
1877
1877
1877
1877
1877

These two measures are of great commercial importance in protecting the safety of the navigation of South Pass.

My thanks are due Mr. C. Donovan, the able assistant in local charge of the examinations and surveys herein shown, for all the information embraced in the report, as well as for the report itself.

Respectfully submitted.

W. H. HEUER,
Major of Engineers.

To the CHIEF OF ENGINEERS, U. S. A.

APPENDIX R.

IMPROVEMENT OF VARIOUS WATER-COURSES IN THE STATE OF LOUISIANA—IMPROVEMENT OF SABINE PASS AND OF SABINE AND NECHES RIVERS, TEXAS.

REPORT OF MAJOR W. H. HEUER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Amite River, Louisiana.
2. Tangipahoa River, Louisiana.
3. Tchefuncte River, Louisiana.
4. Tickfaw River, Louisiana.
5. Bayou Teche, Louisiana.
6. Connecting Bayou Teche with Grand Lake at Charenton, La.
7. Bayou Black, Louisiana.
8. Bayou Courtableau, Louisiana.
9. Bayou Terrebonne, Louisiana.
10. Bayou La Fourche, Louisiana.
11. Calcasieu River, Louisiana.
12. Calcasieu Pass, Louisiana.
13. Sabine Pass, Texas.
14. Sabine River, Louisiana and Texas.
15. Neches River, Texas.
16. Removing sunken vessels or craft obstructing or endangering navigation.

OFFICE UNITED STATES ENGINEERS,
New Orleans, La., July 8, 1886.

GENERAL: I have the honor to transmit herewith my annual reports for the fiscal year ending June 30, 1886, for the works of improvement and examinations and surveys in my charge.

Very respectfully, your obedient servant,

W. H. HEUER,
Major of Engineers.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

R 1.

IMPROVEMENT OF AMITE RIVER, LOUISIANA.

The original project for improving this river was adopted in 1880, the object being to obtain a channel of navigable width and 5 feet depth at low water, or as near that as possible without dredging, from the junction with Bayou Manchac continuously up-stream as far as the appropriation would permit. By act of Congress approved June 14, 1880, the first appropriation of $8,000 was made for this work, following an ex amination authorized March 3, 1879, and a contract was made in Oct ber, 1880, providing for the clearing of the river for a distance of miles up-stream from the mouth of Bayou Manchac for $7,650. Marc 3, 1881, an additional appropriation of $5,000 was made, and the proje for its expenditure provided for extending the work beyond the point be reached by first contract. An accepted bidder for the second co tract failed to furnish bonds, and the contract was therefore not com pleted. Work under the first contract was accepted March 15, 188 having been before reported as finished, but upon inspection was r jected. In February, 1883, a modified project for expending balance appropriation on the river below Bayou Manchac was approved, th work to be done by hired labor, the necessary plant to be construct and paid for from appropriations for work of improving Tickfaw, Tch functe, and Amite rivers. The boats were finished, and with them an hired labor work was begun in December, 1883, at the junction of Bay Manchac and the Amite and continued down-stream only about 8 mil the appropriation being nearly exhausted. This work resulted in th removal of all obstructions as far as Port Vincent, 4½ miles below whi point only those overhanging trees which were materially in the wa and the snags in and near the channel were taken out, leaving ma which may, by shifting their positions, hereafter become obstructions either side of the channel. There remains on this part of the river abo 8 miles on which no work has been done.

On the Amite, above the mouth of the Manchac, as far up as th Comit, 17 miles of work was done by contract, but there are now so ma logs, trees caved in, and other obstructions that this portion is unna gable except for very light-draught boats.

In order to complete the work on the lower river and go over the co tract work on the upper, an estimate of $8,205 is made in the report Maj. Amos Stickney, 1884. Major Stickney says in this report th work done by contract has not been of any apparent benefit, while th done by the Government boats and hired labor has given much sati faction.

No work has been done during the past fiscal year. No expenditu have been made, except for care of property. Under date of Novemb 11, 1885, I wrote to the Chief of Engineers a letter, from which the fo lowing extract is taken:

The estimated value of the property of the above-named work was follows:

Improving Amite River, Louisiana	$2,3
Improving Tchefuncte River, Louisiana	
Improving Tangipahoa River, Louisiana	9
Improving Tickfaw River, Louisiana	1

If there is to be any more work done on any of the above-named riv ers the plant of these works combined will be sufficient. If the pla of the Amite River is to be sold, the property of the three works cite above should be transferred to the Amite property return, and then al be sold, as we have no funds to care for or sell the property belongin to these works.

We have on November 1, 1885, the following amounts:

Improving Amite River, Louisiana	$61 9
Improving Tickfaw River, Louisiana	33 7

From the Amite River appropriation there is the pay due of a watch man from November 1, at $15 per month.

I would respectfully recommend that this plant be retained until the meeting of the next Congress, then if there are no appropriations made for the above works that the plant be sold.

This recommendation was approved by the Chief of Engineers, United States Army, November 17, 1885.

The value of the commerce of this river is estimated at $250,000 annually, the principal products being sugar, molasses, staves, shingles, lumber, and wood.

Should any further appropriation be made for this work it will be used in continuing the project as made.

Money statement.

July 1, 1885, amount available	$121 99
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	120 00
July 1, 1886, amount available	1 99
Amount appropriated by act approved August 5, 1886	2,000 00
Amount available for fiscal year ending June 30, 1887	2,001 99
Amount (estimated) required for completion of existing project	6,205 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	6,205 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

R 2.

IMPROVEMENT OF TANGIPAHOA RIVER, LOUISIANA.

An appropriation was made in 1872, and was expended in clearing the river of snags, rafts, and leaning trees over a distance of 16 miles from its mouth.

Examination and survey were authorized June 18, 1878. The survey was begun in 1879. The assistant engineer who made the survey found many obstructions, such as snags, overhanging trees, &c., and estimated the cost of their removal up to Connor's Bridge, 1½ miles from Amite City and 58 miles above the mouth, at $10,000. This improvement would give a clear channel 42 inches deep to a point 32 miles above the mouth and for a farther distance of 21 miles a clear channel of 24 inches.

An appropriation of $5,000 was made June 18, 1880. On September 22, 1880, agreement was made with Carl P. Segmet for clearing 34 miles for the sum of $4,750.

On March 3, 1881, an appropriation of $2,000 was made for continuing the improvement. The approved project for expending this sum provided for continuing the work above the point to be reached by first contract. One bid was received on this, and, being considered excessive, was rejected. The first contract was reported completed in November, 1881, and the work was accepted. On January 3, 1883, a contract was made with C. E. Cate for clearing out 7½ miles, at $235 per mile. The work was accepted late in June, 1884, having been reported twice as finished and twice rejected.

On July 22, 1884, the charge of this work was transferred to Capt. Thomas Turtle, Corps of Engineers, by Maj. Amos Stickney, Corps of

Engineers, in accordance with letter of instruction from the Chief o Engineers, United States Army, July 11, 1884.

On August 14, 1884, the Government plant that had been laid up a Springfield with a hired crew proceeded, in charge of a superintenden to the Tangipahoa River, under instructions to commence work whe Cate's contract ended, and extend the improvement, if practicable wit the funds on hand, to Amite City. The stage of water was very lo and after forcing a passage through numerous obstacles, such as stump sunken logs, overhanging trees, land-slides, shoals, and two woode bridges to within about 4 miles of the point at which it was intende to begin work, it was found impracticable to proceed any farther, an under a modification of instructions the plant was dropped down t Lanier's Bridge, and the work of cleaning out the stream from the down to the mouth commenced September 15 and was completed Oct ber 11, 1884.

The charge of this work was transferred to me by Capt. Thom Turtle, Corps of Engineers, on the 12th of February, 1885, in accor ance with Special Orders, No. 6, paragraph 3, January 8, 1885.

About 12 miles of the 53½ miles included in the project for the i provement of Tangipahoa River have not been touched. Major Stic ney's last report recommends an appropriation of $1,700 to be mad for completion, to be applied, however, in recleaning the lower rive which is again obstructed. He also suggests that it might be well t consider now some plan for moving the bar at the mouth, which pe mits only light-draught vessels to enter. The work for the lower rive has been completed, an appropriation of $2,000 having been mad July 5, 1884. It is believed that it will be useless to carry the i provement any farther up stream, and if $1,700 be appropriated b Congress in accordance with the original estimate, it will be applied t recleaning out that portion of the river which has already been i proved.

The work is not a permanent one, as obstructions are reforming, an is purely of local importance. It is not known that any benefits hav resulted to commerce since the improvements have been made.

No work has been done during the past fiscal year, no appropriatio having been made since that of July 5, 1884.

Money statement.

Amount (estimated) required for completion of existing project........	$1,70
Amount that can be profitably expended in fiscal year ending June 30, 1888	1,70
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

R 3.

IMPROVEMENT OF TCHEFUNCTE RIVER, LOUISIANA.

The project for the improvement of this river was made in 1880, an contemplated the removal of overhanging trees, logs, &c., in the channe and the dredging of the bar at its mouth. The first appropriation o $1,500, was made March 3, 1881, and a second one of $1,500 in Augus 1882; with these two appropriations the obstructions below Covingto were removed, and part of the unexpended balance was used for th construction of a working plant for improving the bar at the mout and part for the construction of a breakwater extending 820 feet into the lake.

The original estimate for improving this river was $5,460, the greater portion of which was for dredging the bar at the mouth. It was thought, however, that a dredged channel over this bar could not be maintained without protecting works, which would cost considerably more than the dredging.

Major Stickney, who had this work in charge, caused a re-examination to be made in 1884, and in his report in the Annual Report of the Chief of Engineers for 1874, vol. 2, page 1269, he reports the river in good order, excepting the bar at its mouth, and suggests, as a method for improving the bar to build a jetty or breakwater 2,500 feet long across the bar into the comparatively deep water of the Lake Pontchartrain, and then to dredge the channel through the bar, in the hope that the jetty would prevent, or at all events greatly retard, the refilling of the cut with sand. The estimated cost of this improvement is $20,400, and, if authorized by Congress, $19,000 of this amount should be appropriated for the fiscal year ending June, 30, 1888, and applied to extending the breakwater, dredging the bar, and removing any other obstructions that may have formed since the river was cleared out. Should the improvement be made as contemplated, the protection of the mouth of the river would also enable vessels navigating the lake to use this mouth as a harbor of refuge in case of gales. The depth of water on the bar at its lowest stage (during a norther) is about 4½ feet.

The improvement thus far made has not been of any material benefit to commerce.

The report of 1884 estimates the annual value of the products carried down the river at $106,500, consisting of sugar and molasses, cotton, wool, brick, sand, charcoal, lumber, beef, and hides.

The improvement, if made, will be of local benefit only, and cannot be considered permanent, as the obstructions will eventually re-form.

No work has been done during the past fiscal year, no money being available. The work is located in the collection district of New Orleans; the nearest light-house is at the mouth of the river.

I append First Lieut. O. T. Crosby's report upon an examination of the mouth of the Tchefuncte River, Louisiana.

Money statement.

Amount (estimated) required for completion of existing project........	$19,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	19,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

REPORT OF LIEUTENANT O. T. CROSBY, CORPS OF ENGINEERS.

NEW ORLEANS, LA., *July* 3, 1885.

SIR: I have the honor to report as follows upon an examination of the mouth of Tchefuncte River, Louisiana, made by me on July 1, in obedience to your verbal orders. I was assisted by Mr. C. D. Anderson.

With transit and stadia the position of the partially completed jetty was determined and lines of soundings directed. The results have been plotted and the chart is herewith submitted. Comparing it with that made before the jetty was built, it will be seen that the lines are nearly the same. The distance between and the directions of the 6-foot curve on the outer slope of the bar and the inner 4-foot curve are almost exactly the same. Some changes between these in the positions of the 5-foot curves are observable, but they are immaterial. Substantially it may be said that no effect has been produced, nor could any be expected before the building of that part of the jetty, which in the original project made a considerable angle with the inner part, and presented an obstacle to the flow of the sand moved by easterly torms.

Should any further work be done here, I believe an adherence to the original plan—extension of the jetty and dredging across the bar of compact sand—would be the easiest course.

Some of the river men, officers of the steamer Grover Cleveland, informed me that they desire no other improvement than the placing of a beacon on the east point of the mouth, so that in dark nights they could make the channel by steering between the light-house and the beacon. They further assert that the jetty is an obstacle, inasmuch as it prevents boats from hugging the east shore during the prevailing easterly winds, thus exposing them to the danger of being driven across the narrow channel on the west-shore shoals. Steamboats drawing 5 feet have stuck on the bar, and some of the larger schooners in the Tchefuncte trade sometimes wait for a rise of the wind-tide to let them pass, but generally there is little complaint. Although there is as yet, so far as I can see, no reason to doubt the efficacy of the original project for obtaining increased depth across the bar, it might be wise, in view of the above-reported opinions, to await an indication of expanding commerce before spending more money on the work. As almost the entire business of the river is done with the city and through the two canals entering the old and new basins, the demand for greater draught can scarcely occur until a new line of business is established, running to deeper harbors than those afforded by the canals.

The jetty, 840 feet long, has stood one severe storm, losing a few of the binders which connect the piles. The brush is still in place, and the whole structure, unless attacked by unusually severe storms, will probably remain in fair condition until the people concerned and Congress shall have expressed their wish in the matter.

Very respectfully, your obedient servant,

O. T. CROSBY,
First Lieutenant Engineers.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

R 4.

IMPROVEMENT OF TICKFAW RIVER, LOUISIANA.

The work originated in an examination authorized by act of Congress approved March 3, 1879, a report of which, with plan and estimate of cost, was published in Report of Chief of Engineers for 1880, Appendix M.

The estimate of $10,230 for improvement included the branches Blood, Natalbany, and Pouchatoula rivers. The project was adopted in 1881 the object being to obtain a channel of navigable width and depth for a distance of 26 miles up-stream by clearing out obstructions, such as snags, logs, trees, &c. The first appropriation of $2,000 was made March 3, 1881, and a contract entered into with Mr. Fagan on October 5, 1881 The work, by contract, commenced January 4, 1882, and 16 miles were reported as cleared in the Report of the Chief of Engineers for 1882. In act of Congress of August 2, 1882, an additional appropriation of $2,000 was made, and the project for its expenditure provided for a continuance of contract work, but the inefficiency of the lowest bidder and the general unsatisfactory condition of contract work of this kind in the district caused the plan to be changed. Authority was received in the latter part of 1882 to contract for the improvement of the Amite and Tchefuncte rivers; a wrecking plant to be paid for out of the appropriations for the Amite, Tickfaw, and Tchefuncte rivers. Under this arrangement about two months' work, with hired labor, was done on this river by the new plant in the spring of 1884, and resulted in obtaining good navigation 9 miles farther up-stream than schooners had before gone.

No work on the branches of the Tickfaw has been done.

The commerce of the four streams is carried by about 15 schooners per week. The benefit to commerce resulting from the improvement of this stream is purely local. It would result in very little advantage to improve navigation any higher up in the Tickfaw, but the branches of this stream, the Blood, Natalbany, and Ponchatoula, are in need of improvement, and are part of the project estimated for in 1880. It is, therefore, recommended that no further appropriation be made for the Tickfaw unless the money so appropriated can be applied to the branches referred to. In this event, the $6,230 estimated for will complete the whole project estimated for.

Nothing has since been done on this river other than that necessary for the care of the plant now laid up at Springfield, La.

Money statement.

July 1, 1885, amount available	$33 72
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	30 00
July 1, 1886, amount available	3 72
Amount appropriated by act approved August 5, 1886	2,000 00
Amount available for fiscal year ending June 30, 1887	2,003 72
Amount (estimated) required for completion of existing project	4,230 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	4,230 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

R 5.

IMPROVEMENT OF BAYOU TECHE, LOUISIANA.

On May 5, 1870, an appropriation of $500 was made for a survey and estimate of cost of improvement of Bayou Teche. The survey having been made and reported, an appropriation of $17,500 was made July 11, 1870. With this money much relief was given by removal of natural and artificial obstacles, such as overhanging trees, snags, and wrecks between the mouth and Saint Martinsville, a point about 65 miles above the mouth. The work was done by hired labor, and for a sum considerably less than that appropriated, Captain Howell, the officer in charge, having found it best to abandon some features of the original project, such as the cutting of brush along the bank.

March 3, 1879, an examination of this bayou was authorized by Congress, a report of which, together with plans and estimates, was published in Report of Chief of Engineers for 1880, Appendix M. The improvement recommended in this report had in view the obtainment of slackwater navigation as far up as Léonville, about 109 miles from the mouth and 13 miles from the head of the bayou. Three timber locks with needle-dams were recommended, besides removal of snags, &c. The total estimate of costs was $58,190, of which $45,000 was for the three locks and dams, of 7-foot lift each. No clearing of the river for the 13 miles above Léonville was provided for, as the information obtained in the reconnaissance of 1879 led to the belief that there was no water for the passage of boats except at extreme floods. This report was submitted February 27, 1880. On June 14, 1880, an appropriation of $6,000 was made for commencement of the work. It was expended in removal of snags, overhanging trees, &c., between Saint Martinsville and Léonville, or Léon's Bridge. The work was reported completed in June, 1881, and, after an inspection by Assistant Engineer H. C. Collins, was accepted.

Subsequent examinations and the concurrent testimony of all river men interested lead to the conclusion that the work was done in a very unsatisfactory manner. Trees were cut down to a high-water level, leaving many dangerous stumps. The same section of the bayou would certainly have to be worked over again in any systematic improvement. March 3, 1881, an appropriation of $20,000 was made. In submitting a report for its expenditure, Major Howell recommended the making of a detailed survey before precise plans were attempted. This recommendation was approved May 12, 1881. The survey was begun in October, 1882, and completed March 13, 1883. It extended from the head to Charenton, a point about 30 miles above the mouth. The data obtained by this survey showed that with two locks having a lift of about 8 feet each 5 feet depth could be carried to within 4 miles of Port Barré, at the head of the Teche, and that in ordinary high water this distance is also navigable. Whether it would be worth the cost to improve this reach by considerable dredging was considered questionable. While the ordinary supply was thought probably sufficient, reference is made to the fact that Spanish Lake, lying near Saint Martinsville, could be readily drawn upon for an increased supply, if necessary.

The position of the lower lock was assigned in a further report on the same survey, published in 1884, at a point about 5 miles below Saint Martinsville; this to carry 5-foot navigation as far as 17 miles above Saint-Martinsville and 2 miles above the village of Breaux Bridge.

The original estimates were considerably changed. Each of the two locks with accompanying dam was estimated at $45,000. A small amount of dredging, removal of snags, &c., with 25 per cent. contingency fund, carried the total estimate to $135,625. It was recommended that the lock be of brick, instead of wood. Detailed drawings were prepared, but not until *after* the above estimates were submitted.

The appropriation of $20,000 in 1881 was for improving Bayou Teche, between Saint Martinsville and Port Barré.

On July 5, 1884, an appropriation of $6,500 was made for "continuing improvement." Captain Turtle, who assumed charge of this work July 23, 1884, in a letter to the Chief of Engineers, dated January 12, 1885, recommended that of this last appropriation as much as might be needed should be applied to the removal of obstructions from the mouth up, the work to be done by the Government-wrecking plant then on the Bayou La Fourche.

He also recommended that additional data, such as discharge and low-water slope bearing on the lock project be obtained and paid for from the appropriation of 1881. These recommendations being approved the wrecking plant was transferred to the Teche in February, 1885, and has since been constantly employed there.

Nearly the whole of the month of April was occupied in removing the wreck of the Chambers, the cost of the work being borne by the general appropriation for removal of wrecks.

The survey previously made having terminated at Charenton, Lieut. O. T. Crosby was, in May, 1885, ordered to complete the transit work to the mouth and carry the level line to Morgan City, on the Atchafalaya, where a gauge had long been read. The work was completed June 4, 1885, and report thereon submitted. There being no reliable information as to low-water discharge of the bayou, this important element of the problem was determined in September, 1885, Lieutenant Crosby making the observations. My letter transmitting the report submitted to me by Lieutenant Crosby, together with that report, are given herewith as containing the results of investigations and my recommendations thereon. In my last annual report it was stated:

> I do not recommend any appropriation for slackwater improvement until the necessity for such improvement is made absolutely necessary, and certainly not until the snags, trees, stumps, &c., now known to be in the upper part of the bayou are removed and the effect of their removal is seen in the improved navigation.

During the past fiscal year a large part of the work referred to in the above paragraph has been accomplished. At the date of my last annual report, the United States Snag-boat was working between New Iberia and Saint Martinsville. Under the direction of Lieutenant Crosby, the snagging operations were continued about 10 miles above Saint Martinsville. At this point the boat was prevented from going further by the low stage of water, September, 1885. A land party was then organized, which began work about 3 miles above Breaux Bridge and about 8 miles above the point where the boat stopped work. These 8 miles were too deep for successful working of a land force and moreover were comparatively free from obstructions.

The land party cleared about 15 miles of the very shallow and much obstructed portion of the bayou.

They reached a point about 5 miles above Arnaudville, the last village met in ascending the Teche, 19 miles from its head. Throughout the 14 miles still untouched the bayou is narrow, tortuous, and overgrown with large trees. The work of the land party was stopped by high water in January, 1886.

The snag-boat which had been put at work on the lower bayou during the very high water on the upper part, removed all serious obstructions between New Iberia and Franklin, below which point no trouble is experienced.

In January, although the water at Breaux Bridge was still too high for the most successful work with the snag-boat, it was ordered up to the 8-mile stretch, previously omitted, and the worst obstructions were removed. In March, the water having risen higher, work was stopped, and since then nothing has been done save for care of property.

As a result of this work, in February, 1886, there existed in the opinion of Lieutenant Crosby, who carefully examined the stream, a channel sufficient to permit a vessel 40 feet wide, drawing 5 feet, to ascend to a point 3 miles above Arnaudville, and 2 miles further except for the obstruction of a fixed bridge. The commercial effects may be judged from the following correspondence:

NEW ORLEANS, LA., *June* 3, 1886.

SIR: You will please report to this office all the reliable information you can obtain as to the number of steamboats or flats that have gone above Breaux Bridge since the cessation of work on the Teche, the size of such boats, the number and extent of their trips, and amount of freight carried. Also, whether you have any reports or authoritative opinion as to the navigation of the upper Teche.

By order of Major Heuer.

Respectfully,

O. T. CROSBY,
First Lieutenant, Engineers.

MR. PETER OLIVER.

UNITED STATES WRECKING FLAT,
Breaux Bridge, La., June 5, 1886.

SIR: I have the honor to report that the number of steamboats that have gone above Breaux Bridge since March, 1886, is as follows: 1. The Danton, two trips, with flat-boat in tow, carried merchandise up and 1,500 sacks of cotton-seed down each trip. Length of boat about 70 feet. 2. The Mary V. Alice, two trips, with flat-boat in tow, carried merchandise up; coming down loaded at Arnaudville once with 1,500 sacks seed, and once with 1,450 sacks seed and 10 bales cotton. Length of boat about 80 feet. 3. The A. Durio, four trips to Arnaudville, carried up 10,000 feet lumber; brought down 700 sacks of seed each trip. Length of boat about 67 feet. 4. The Hattie Bliss, one trip to Arnaudville, carried theatrical troup. Length of boat, 90 feet. One flat-boat went up carrying 8,000 feet of lumber. Six flat-boats came down bringing 500 sacks of seed, 10 hogsheads of sugar, 15 bales of cotton, bones, and firewood. Lengths of boats from 40 to 55 feet. One of these came through from Bayou Courtableau.

The steamboat captains and pilots, also the owners of the Durio, speak in high terms of the improvement on upper Bayou Teche, and their opinion is that if locks be built the upper bayou will be navigable all the year.

Very respectfully, your obedient servant,

PETER OLIVER,
Watchman.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

Money statement.

July 1, 1885, amount available	$18,005 90
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	10,687 97
July 1, 1886, amount available	7,317 93

PROBABLE WATER-SUPPLY, LOCATION AND ESTIMATED COST OF BUILDING A LOCK AND DAM FOR MAKING SLACKWATER NAVIGATION ON THE UPPER PORTION OF BAYOU TECHE, LOUISIANA.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., March 16, 1886.

GENERAL: I have the honor to forward herewith the report of Lieut. O. T. Crosby, United States Engineers, giving detailed information as to the probable water-supply, location and estimated cost of building a lock and dam for making slackwater navigation on the upper portion of the Bayou Teche, Louisiana.

A condensed history of work done and recommended, appropriations and expenditures made, &c., since 1870, for the improvement of the Bayou Teche, Louisiana, was made in the last annual report and printed in Appendix S, Chief of Engineers' Report for 1885.

At present the bayou is navigable during the entire year as far up as Saint Martinsville. To make it navigable as far up as Arnaudville; or a few miles above there, say 35 miles above Saint Martinsville, during the entire year, will require the building of at least one lock and dam; and probably the best location for this work will be a little below the Keystone Plantation, say 9 miles below Saint Martinsville. The only villages on the bayou above Saint Martinsville are Breaux Bridge, 15 miles distant, Arnaudville, 30 miles distant, and a small settlement called Leonville, about 6 miles beyond Arnaudville. From here up the stream is called the Little Teche, and to where it joins the Bayou Courtableau, at the village of Port Barré, is about 19 miles. Of these upper

19 miles of the Teche I believe it to be impracticable to improve the 4 or 5 miles immediately below Port Barré for stream navigation, except at an expense greatly in excess of any benefit to be derived from such improvement. Occasionally, when the Little Teche is in a flood-stage, barges come down from the Courtableau, pick up what little freight offers; they are polled or cordelled back to the Courtableau, the cargo transferred to steamboats, and finds a much shorter water route to market at New Orleans than would be possible via the Teche. The upper 6 miles of the Little Teche is but little more than a gully; its banks are very steep, heavily timbered, and if it had, say 5 feet depth of water in it, the width of water surface would scarcely average 20 feet. During a large portion of each year this part of the bed of the bayou has no water in it except in little pools; in fact this portion of the stream becomes dry. When the bed of the Little Teche is dry and the Courtableau is low, the *bed* of the Teche is 8 feet above the *surface of the water* in the Courtableau, and if a depth of 4 or 5 feet of water could be kept near the head of the Little Teche, it would have to be done by means of a dam or wall in the Little Teche or a lock and dam in the Courtableau, at or near Port Barré. If a lock and dam be built in the Little Teche, at or near its head, vessels could not be locked into the Courtableau, because of an insufficient water-supply, and if the lock and dam were built in the Courtableau, the cost of this lock and dam would probably be greater than that estimated for by Lieutenant Crosby near Saint Martinsville in the Teche.

If a lock and dam should be built below Saint Martinsville, on the Teche, it would only benefit that section of country above; that is, the villages of Breaux Bridge, Arnaudville, and Leonville, and the plantations intermediate.

To Breaux Bridge the bayou is ordinarily navigable during ten months of the year, and to Arnaudville, perhaps, for three months in the year. Leonville is a very small settlement of about two stores. By far the greater portion of the products of the country above Saint Martinsville reach market at New Orleans by rail, and fully 90 per cent. of the output of this section of the country, though it may come down the bayou by boat, is transferred to the Morgan Railroad, either at Morgan City or the Atchafalaya, or at some other station, and then reaches New Orleans by rail.

The products of the country for shipment above Saint Martinsville are cotton, sugar, and rice.

The statements concerning the amounts of each shipped in late years are very conflicting; with reference to cotton, reports vary from 2,300 to 6,000 bales. In 1884, 2,407 hogsheads of sugar were shipped from Saint Martinsville or above, while the total product for that year of the whole Teche was 21,659 hogsheads, or, in other words, only about 11 per cent. of the sugar crop was raised in that portion of the country which would be benefited by the improvement. The freight rates over that portion of the route above Saint Martinsville are outrageous. Dry barrels, such as sugar, flour, potatoes, &c., pay 25 cents per barrel, and wet barrels, such as beef, pork, &c., pay 40 cents per barrel, or, say, an average of 18 cents per 100 pounds for from 15 to 20 miles of water transportation; or, to put the case more clearly, the ordinary freight rates on a barrel of flour from New Orleans to Breaux Bridge are 60 cents, of which 35 cents goes for transportation to Saint Martinsville by rail, 140 miles, or by boat 450 miles, and the other 25 cents for the 15 miles of water transportation.

If we take the total amount of the products shipped to market from that section of the Teche above where the lock may be built, considered by weight in tons, and assume the freight rate for all of this to be at the rate of 18 cents per 100 pounds, or about $4.03 per gross ton, we have as an extreme an annual reported downward tonnage, over this short stretch of bayou, of about 2,280 tons—in round numbers, say 3,000 tons—at $4.00 per ton, an aggregate of $12,000, paid annually for freight (downward) over the route of the projected improvement; it is also probable that the freights paid for inward-bound freights would be nearly as much, or, say, a total amount paid for freights of $24,000 per year.

No railroad touches the bank of the Teche above Saint Martinsville; one little steamboat handles nearly all the freight between Saint Martinsville and Breaux Bridge. This stretch of bayou as before reported is navigable for an average of nearly ten months in the year. The steamboat charges as high a freight rate during high as during low water stages. If the lock were built it would only afford navigation two months longer during the year, and the freight rates would only be reduced in consequence of competition in the trade; that competition does not exist now, not because there is not water enough in the bayou for competing boats, but because there is not trade enough in that section of the country to induce competition even at the present extravagant freight rates.

During the present fiscal year, since the Government has been removing snags and other obstructions between Breaux Bridge and Arnaudville, there have been weeks at a time when the stream was fit for navigation in fact, a 5-foot stage to Arnaudville, but the steamer did not make any trips, probably because there was not freight enough to justify her in doing so.

A large increase in business may induce competition and consequent reduction in freight rates. How much business will be increased in consequence of better navigation, I am unprepared to state or even to guess.

Lieutenant Crosby estimates—

The cost of the lock and dam at about	$175,000
The interest on this at 5 per cent. is	8,750
Annual expense of operations at locks estimated at	4,000
Annual repairs, dredging &c., estimated at 5 per cent	8,750
Total annual expense for operating and maintenance (estimated)	21,500

If the lock were built and business above the lock remained the same as of late years, and the boat or boats would carry freight for nothing in this upper stretch of river, it would save the planters and merchants of this section $24,000 per year, but would cost the United States annually $21,500.

In an engineering point of view it is practicable to build the proposed lock and dam at the site provisionally selected at an estimated expense of about $175,000, and an annual expense for maintenance of $21,500. Sinkers, logs, snags, and other obstructions will continue to form in the Teche as heretofore; they will have to be removed whether a lock be built or not.

Should Congress conclude to sanction the project for building the lock as estimated for, the total amount should be appropriated in one lump.

During the past year the navigation of the Teche has been very much improved. Work on the bayou has now ceased on account of high water. A few months more work would have completed the improvement so far as the removal of logs, snags, stumps, and overhanging trees are concerned. It now remains to be seen whether or not the improvement, which has certainly been of great benefit to navigation, has been of any benefit to the planters of this section of the country; and if any recommendations are desired at this stage of the improvement, I should recommend that no appropriation for a lock be made until the improvement thus far made had been tested.

Respectfully submitted.

W. H. HEUER,
Major of Engineers.

Brig. Gen. JOHN NEWTON,
Chief of Engineers U. S. A.

REPORT OF LIEUTENANT O. T. CROSBY, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., February 1, 1886.

SIR: I have the honor to report as follows upon the measurement of the discharge of Bayou Teche, Louisiana.

The observations were made at a point about half a mile below the Saint Martinsville Bridge, over a straight stretch of 200 feet. Careful cross-sections were taken at every 20 feet of this stretch, the soundings 5 feet apart. An almost perfect uniformity was discovered; the maximum depth found was 5 feet. I have plotted the mean cross-section, and submit it with other plottings.

Tin subsurface floats and wood-surface floats were used, their times of passage under ropes stretched across the stream at upper and lower extremities of the 200-foot stretch being noted. The ropes were marked to every 5 feet. The floats were dropped a few feet above the upper one and opposite predetermined marks, so that time only was to be observed there. Both time and position were marked at the lower rope, and the floats recovered by a man in a skiff. Shortly after beginning the work I settled upon a regular set of observations, consisting of five surface, five 1-foot, three 2-foot, three 3-foot, one 3½-foot subsurface, sixteen in all, made every three or four hours during daylight. At midnight one or two observations were made at a depth of 2 feet, where the velocity was closely proportioned to the mean. A regular nightly decrease is shown by these observations, and their effect upon the mean shows the importance of extending observations throughout the twenty-four hours in all streams influenced in any degree by the tide. I was informed by parties living at Saint Martinsville that a combination of south wind ,high tide, and low water in the Teche will sometimes turn the current up-stream. This state of affairs did not occur during the five days of my observations, but the checking effect of the tide is shown in reduction of velocity from .535 per foot per second, the mean to .311, the minimum observed. Due to local rains the bayou had risen nearly 1 foot the day before my arrival, thus preventing the measurement being made at extreme low water as desired; but before leaving the gauge read 3.9 feet, the mean during low-water season of 1884 being 3.1 feet.

The width of water was 95 feet, the area of cross-section 296 square feet when the measurement began. The variation from these figures was slight. The points of measurement were so distributed over the cross-sectional area as to make it unnecessary to divide into sections and calculate for each separately. This was done at first, five sections being considered, but finding in each section, as in the whole, there was one point of measurement to every 15 square feet of sectional area, I afterward neglected this division. The mean velocity of all the floats was then taken as the mean velocity for the stream. In order to obtain the curve of this mean velocity for the whole time of observation the curve for each float was first plotted from the record, the time intervals of course being unequal, because but one was taken at night. The velocities at exact intervals of three hours were taken from these curves, and being averaged, the resulting ordinates were plotted to produce the mean curve. The daily variation was thus taken properly into account.

The gauge-readings were also plotted. Then the discharge was calculated at the ends of the three-hour intervals and the results plotted. The relation between gauge-readings, and velocity, or gauge-readings and discharge, for the time considered, could thus be seen. The law connecting these quantities, as shown during the time of observation, can not, of course, be relied upon as existing at lower stages, but having plotted the curves showing the two relations, I adopted that giving the least resulting discharge as the true one for use in calculating for stages lower than those observed. This was found to be the curve showing the relation between gauge-readings and mean velocity. The mean velocity for lower stages was taken from the curve indicated by the observed relation, the area of cross-section calculated, and hence the discharge. Since the variation of cross-section per inch of fall is greater at lower than higher stages, the curve indicated by the observed relation between gauge-readings and discharge might be expected to give too great a discharge for lower readings.

The records of 1884 show one or two gauge-readings at Saint Martinsville of 2.3 feet, but the lowest record for any length of time sufficient to be considered is the mean for the week ending November 17, 1884. That reading is 2.5 feet, and it is for readings at that stage that I produced the curves spoken of and calculated the discharge. The times at which the water falls almost to the zero of the gauge are so rare, and their duration so short, that to recede from a project of lock-construction solely on account of calculations that might be made for such a stage would, I think, be a wrong policy. The cross-section at that stage, 0.0 feet, would be 17 square feet, the velocity 0.0 feet per second, the discharge 8.5 cubic feet per second; practically nothing. The gauge-reading 2.5 feet calculated discharge becomes 116,280 cubic feet per hour. A lock 300 by 50 by 10 feet requires 150,000 cubic feet per lockage.

	Cubic feet.
Estimating ten passages per day	1,500,000
Discharge per day 116,280 by 24	2,790,720

Cross-section area being 129.2 velocity, 25 feet per second.

This leaves 1,290,720 cubic feet per day to cover leakage and increased evaporation and seepage, due to increase of width. The length of the first pool, as suggested in previous reports, is about 20 miles.

While, on account of the varying inclination of the banks, it is impossible to calculate closely the increase of water surface for a given rise, an examination of these banks leads me to believe that an allowance of 30 feet increase will err, if at all, on the safe side. This average increase, extending over a distance of 20 miles, gives an additional evaporation surface of 3,168,000 square feet, and, at the rate of 0.2 inch, a loss per day of 26,400 cubic feet. The increase of infiltration is more difficult to determine. The figures heretofore reported for this element are given for the whole area covered, and not for a unit of area, or they are given as bearing a certain ratio to evaporation loss; and they are given for artificial excavations, while we have to consider a natural one. Inspector-General Graeff, of the French engineer service, quoted by Colonel Merrill, Report Chief of Engineers, 1876, vol. 2, page 67, gives as seepage per running foot per twenty-four hours for the whole of an average canal in argillaceous soil 5.27 cubic feet; in sandy soil 3.55 cubic feet.

No other data found are as precise as these. From this I estimate that it will be fair to allow an increased seepage of 1.5 cubic feet per running foot per day, there being an increased wetted area of about 25 square feet per running foot. This for 20 miles gives per day 158,400 cubic feet. As to leakage, American engineers have usually estimated twelve locksful per day as covering the loss. For the case considered this loss would be 1,800,000 cubic feet per day, or about 500,000 cubic feet more than the difference between total needs of supply and leakage, viz, 2,790,720—1,500,000=1,290,720.

Adding together the four items of consumption—

Lockage	1,500,000
Leakage	1,800,000
Increased seapage	158,400
Increased evaporation	26,400
	3,484,800
Supply	2,790,720
Deficiency per day	694,080

Mr. Jervis, engineer of the Erie Canal, as quoted in various reports of the Chief of Engineers, estimates 100 cubic feet per minute per mile as loss due to evaporation, filtration, and leakage.

On this basis a canal 20 miles long would lose 4,320,000 cubic feet. Evaporation and filtration for the normal low water stage of the bayou may be deducted, these losses having been supplied before point of measurement of discharge is reached. Evaporation over area 90 feet multiplied by 20 miles equals 79,200 per day. Filtration at 4.00 cubic feet per foot, 422,400. A total to be deducted from 4,320,000 of 501,600 = 3,818,400 cubic feet; 3,818,400 + 1,500,000 supply for leakage = 5,348,400; 5,818,400—2,790,720=2,517,680 deficiency.

This estimate of losses is probably unnecessarily large for the case before us, but the first calculation could not be safely changed, and its deficiency is 694,080 cubic feet per day. It should be remembered, too, that the assumed number of lockages, 10 per day, is the very lowest which would justify any expensive improvement of a waterway. It is, however, as great as would be found for some years after the construction of the canal, should that occur within the next six or eight years. It is usual to estimate upon a future development of canal navigation far beyond such a figure, and to be assured of a correspondingly greater water supply; but I desired first to determine the conditions for only a small increase of commerce over that now existing, considering that the assumption of a small increase would be at once more favorable to those interested in the improving, and more nearly approached to the truth as it would be developed after construction of the locks.

Preserving this estimate of boat passages, and adopting a mean of the two calculated deficiencies, it is seen that the shortage will be about 1,500,000 cubic feet per day during the continuance of a stage which the records show may last ten or fifteen days. To supply this deficiency in the simplest way suggested by known data the bayou itself may be made a reservoir.

The first or lower section of the canalized portion of the bayou has heretofore been spoken of as having its lower terminus about 5 miles below Saint Martinsville; upper terminus at Breaux Bridge, that being the point at which it has been proposed to build a second lock, carrying navigation to within 4 miles of Port Barré, the head of the bayou; both locks of 8 feet lift. But a lock of 10 feet lift about 5 miles below Saint Martinsville would give a depth of 8 feet as far up as Arnaudville, 15 miles above Breaux Bridge and 19 miles below Port Barré, the pool being supposed level, the most unfavorable case for depth up stream. This pool may be lowered 3 feet, leaving 5 feet navigation as far as Arnaudville. Estimating the average width of the bayou at 100 feet, we have a supply by this lowering of 100 feet × 3 feet × 35 miles = 55,440 cubic feet. Increased seapage and evaporation over that calculated for the shorter pool will be about 500,000 cubic feet per day, making daily deficiency 2,000,000 cubic feet, which the lowering above referred to will supply for twenty-seven days.

Three feet navigation would be preserved to a point 5 miles above Arnaudville after lowering. This calculation supposes another lock to be eventually built at Arnaudville. Should there be no other, the length of the pool would be about 52.5 miles, the supply by lowering 83,160,000 cubic feet, the daily shortage about 2,400,000; 83,160,000 ÷ 2,400,000 = 34.9 days. A lock having 12 feet lift would preserve 5 feet navigation after a fall of 5 feet at Arnaudville. The supply from such lowering (the pool extending above Arnaudville) would be 138,600,000 cubic feet, which is equivalent to a deficiency of 3,000,000 cubic feet per day for 46 days. Before the lowering of such a pool, 3 feet navigation would be given as far up as a point about 5 miles from Port Barré. At this point the bottom of the bayou rises quite rapidly, constituting an effective barrier to prevent the pouring over of the accumulated supply into the Courtableau, which during low-water seasons would be at a lower level than that proposed for the pool. Should it be desired in future to establish navigable communication between the Courtableau and the Teche, artificial means for regulating the flow between the two streams would of course be resorted to. The bottom of the Courtableau at Port Barré is 23 feet lower than the bottom of the Teche one mile below Port Barré.

The facts above stated as to reach of navigation and supply of water attainable by lowering the pools, the locks being of 10 or 12 feet lift, are based upon the supposition that the normal low-water stage, above which the lifts are measured, gives a reading of 2.5 feet on the Saint Martinsville gauge. It will be noticed also that the pool is supposed to be closed by a water-tight dam, whether permanent or movable. The stored-up water supply as calculated seems more than sufficient, even with a 10-foot lock, for all demands that may be made upon it. It will be rare indeed that the natural flow during a period of thirty days would not exceed the needs of lockage, leakage, &c. But the surplus is not large enough to permit any laxity in regulating the consumption. Hence, although a movable dam is of course to be preferred, no variety can be considered which is not practically water-tight. The time of closing the lock, and whatever other openings might exist in connection with it, during high water would be determined by the needs of navigation in the upper part of the pool, where the inconvenience of low water is first felt. This necessity of looking to the upper part would secure the closing of the lock early enough to insure the filling of the pool before the natural flow became less than consumption. To illustrate this, suppose increased depth were needed at Arnaudville when the guage at Saint Martinsville reads 7 feet (this of course is an extrême case) the cross-sectional area would then be 600 square feet, the mean velocity about seventy-five one-hundredths foot per second, the daily discharge about 40,000,000 cubic feet. To fill up to 12.5 feet on the guage, that being the reference of the top of the dam with 10-foot lift, would require 150,000,000 cubic feet. This could be done in about four days with the surplus over lockage needs, the bayou supposed to be constantly discharging as much as when at the reading 7 feet. A similar calculation made for a 4-foot stage shows that about thirty days would be required to fill the pool with the surplus that would be constantly delivered at such stage. In practice it would usually be found that up-stream navigation would require closure of the lock while the water showed somewhere between 7 feet and 4 feet on the gauge at Saint Martinsville. The time for opening the lock would be determined by the amount of overfall and by reference to gauge records in case it should ever be desired to open it. With a *movable* dam placed at a point where the slopes are such as found at the point of discharge measurement, the opening of the lock alone, in addition to the dam, would secure sufficient area of water-way at high-water stages. At that point the slope of the bottom and banks for some distance from the water's edge, was about 1 on 8.

Suppose the outer lock-wall to be in mid-stream.

	Square feet
Then added water-way due to lock excavation $= 50 \times \frac{6.2}{2}$	15
Then added water-way due to dam excavation $= 140 \times \frac{18}{2}$	1,26
Total	1,41

This supposes the dam to be laid on a level floor, placed as low as the bottom in mid stream, and to be 18 feet high.

	Square feet
Then water-way subtracted by lock-walls = 2 by 20 by 10 =	40
Leaving for abutments, &c	101

Since the site has not yet been determined and the slopes are therefore not known, it is impossible to submit this matter of water-way for floods to close calculation, but it is seen from the above rough estimate that in the case of a movable dam, no fear need be had of being unable to provide sufficient cross-section.

Should the dam be fixed, the height to which it is necessary to hold its crest in order to make a reservoir of the bayou makes it necessary to provide some other outlet than that offered by the open lock and the over-fall. The high water of 1884 rose to 18.6 feet on the gauge at Saint Martinsville; the high water of 1882 to 18.8 feet; that of 1874 to 14 feet; that of 1883 to 15 feet. A dam giving 10 feet lift would have its crest at 12.5 feet; a dam giving 12 feet lift would rise to 14.5 feet. The flood of 1882 was exceptional; the left bank of the Teche was submerged, the water-surface being continuous from the right bank to the Atchafalaya River. For such a flood no calculation need be made. The flood of 1874 was considered unusual, but it was kept within the banks, and indicates the limits to be observed in raising a pool. Even this height is detrimental, as the sloping banks of the bayou give the back-yard space for many houses. Without having any exact data on the subject, scattered information received by me concerning the flood of 1882 leads me to believe that a flood rising to 15 feet on the gauge would be held within the banks—that is, within the ridges sometimes distant 100 or 150 feet from the bluff banks. At least it will be safe to assume it necessary to prepare for discharging such a flood, though rising higher and submerging the banks, like that of 1882, need not be considered. Indeed, it is doubtful whether that flood height was due to water coming down the bayou; rather, the Atchafalaya waters, spreading westward, reached the Teche banks and overflowed into the bayou. A typical sectional area, as given by the survey of 1882, at a point near that at which it has been proposed to place the lower lock, contains 4,125 square feet below the 15-foot mark of the gauge. Area below 11.6 feet (high water of 1884) 2,775 square feet. From rough measurements made by myself during a high stage—not the highest—in January, 1885, and from rough measurement or guess of flood velocity reported by Assistant Engineer H. C. Collins, I find that 2 feet per second may be assumed as mean high-water velocity, giving a discharge per second for the larger area mentioned above 8,250 cubic feet; for the smaller, 5,520 cubic feet. With the lock closed, the water discharging over the dam, the formula, $Q = 3.33 \times l \times \sqrt{h^3}$ (Trautwine) shows that the smaller flood would pass over a 395-foot dam for 10-foot lift without raising the pool higher than 15 feet on the guage. Q, quantity discharged; l, length of dam; h = head, measured from top of dam to surface of water just above the comb. The length, 395 feet, is found by substituting for Q 5,550 feet, for h 2.5 feet, the limiting height above the dam. But for the larger flood no increase of height is allowable; and if it were, the formula would not apply, since the pool *below* as well as that above must be higher than the dam, and there would be no clear fall from the dam, as is supposed.

If, then, a flood which just remains within the banks be provided for, no contraction of water-way is allowable, since any such contraction must raise the flood-surface. Such floods as that of 1874 do not often occur, but since two such floods, and another yet higher, have occurred within the same decade, I think its recurrence should be anticipated. To construct sluices on the flanks of or underneath a permanent dam, and having, with the open lock, an area of 4,125 square feet, would, perhaps, not be impracticable, but its cost would evidently be very much larger than the difference between the cost of a movable and the cost of a permanent dam.' There is, moreover, the advantage of having an open water-way during a part of the season. While it thus appears that, for several reasons, we should certainly prefer the movable dam, yet the great height of such a dam as mentioned above, when considering it alone, renders it both costly and cumbersome. But I find that a combination of the two systems may be applied to the cross-section referred to before as taken from the survey of 1882 in such manner as to avoid the great height of movable structure and yet maintain an undiminished water-way, the lock being open. The accompanying sketch on tracing paper shows this cross-section and two arrangements of the dam. In the first of these there are 250 feet of movable dam 10 feet high, and 88 feet 6 feet high. In the second there are 194 feet of movable dam 12 feet high, and 88 feet 6 feet high. In both, the dam rises to 15 feet on the gauge and rests either on top of the low-submerged permanent dam, or on a floor laid in an excavation. In both, the areas subtracted by lock-walls and permanent dams are practically equal to those added by excavation, so that when the lock-gates are open and the movable dam down the flood area is the same as in an unobstructed cross-section. In the second case the top of the permanent dam is placed so low that, the water standing at 7 feet on the gauge, a boat drawing 5 feet could pass over this dam. Vessels may, of course, pass through the open lock at high stages, since there would be no increase of current through it save the slight combing around the walls; but the wide water-way at its side would certainly be of great convenience as a passing place, especially if a considerable settlement should grow up near the site of the lock. Estimating the permanent dam to be of an average thickness of 12 feet, there would be about 60 cubic yards of it in the first case and 50 cubic yards in the second. In estimating the earth to be excavated it is necessary to consider not only the quantity the removal of which would permit the construction and manipulation of the movable dam in a sort of transverse ditch, but also quantity removed in cutting down the sides of this ditch up and down stream. Otherwise the water would eddy in this ditch and the cross-section of the stream at the dam would not be efficient for flood delivery as elsewhere.

Suppose the approaches to be begun at points 100 feet above and below the dam, and to be made by removing the earth lying within the right lines drawn from all points of the perimeters of the areas of excavation, as shown on the cross-section plotted, to any point of the bank on the same side with the area considered, and at a distance of 100 feet up or down stream. There would be four such pyramidal volumes, aggregating about 3,000 cubic yards. Of this amount, however, a very large part, if not all, could be profitably used in constructing the necessary coffer-dams. The determination of the proper relation that should exist between areas of excavation and of the movable and permanent parts of the dam must be delayed until the site of the lock is definitely chosen and the form of cross-section accurately known. The relative cost of permanent and movable dam per linear foot, and change in cost due to change in height of movable dam, must also be known.

Some such combination as the two suggested, of permanent and movable parts in the same dam, will, I believe, best suit the needs of the case, under the supposition that the bayou be made its own reservoir.

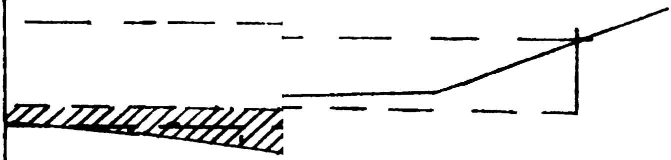
It remains to be said concerning the water supply that the availability of Spanish Lake as a source of supply has never yet been determined with exactness. But since this report was begun I have made examinations of it sufficient to convince me that enough water may be had from it to supply deficiency in the Teche, and that it may be had without large expenditure. Should this expenditure be equal to or even somewhat exceed the difference between cost of dam and lock without, and the cost with, extra height for holding surplus water in the bayou itself, then this plan of using Spanish Lake would be preferable. As has been said, the high pools previously calculated upon might cause inconvenience to many back yards, and might further interfere with the drainage system on many plantations. The area of Spanish Lake was estimated by Assistant Engineer Collins at about 6 square miles. Hardee's official map of Louisiana makes it between 5 and 6; my own estimate was the same. Assume the area to be 5 square miles=139,392,000 square feet—or, we may say, that by lowering the surface of the lake 1 foot we obtain 140,000,000 cubic feet of water= a daily deficiency of 2,000,000 cubic feet for seventy days supplied. The depth I judge to be irregular, as persons who have made chance soundings report from 6 to 20 feet. I found no more than 6.5 feet out to a distance of about half a mile from shore, along a line in prolongation of the line of the small canal leading to Bayou Teche through Keystone plantation. Even if no greater, this depth is sufficient for the purposes in view. I learn from Mr. Peters, in charge of the Keystone plantation, that the lake varies its surface level about 2 feet between times of heavy rains and times of drought. When seen by me it was at about mean stage. This mean stage is about 16 feet above low water of the Teche, and in the ditch or canal now connecting lake and bayou this whole fall is effected over a distance of about half a mile, nearly the whole of the first mile being at the level of the lake, the whole length about 1.5 miles. The high water of 1882 met the lake water in this canal, and there was practically no fall; but suppose a pool be raised to 10 feet on the Saint Martinsville gauge, giving 5 or 6 feet at Arnaudville, then there would be a fall or 8 or 10 feet from lake to bayou. The nearly level part of the ditch referred to is about 8 feet wide, and, at mean stage of the lake, about 2 feet deep. It can be deepened to 4 feet by going about 100 feet from shore into the lake. This would secure a depth of 3 feet at low water of the lake. The bottom of such a ditch would be about 6 feet above the pool in the bayou, its end about one-third of a mile from the point in the gulch to which the pool would ascend. By placing a dam in the ditch at the end of the level stretch (where the cut through the ridge begins) the delivery might be regulated and measured. An overfall 10 feet wide and 1 foot deep from comb of the fall to crest of dam delivers 33 cubic feet per second, or 2,851,200 cubic feet per day. To increase the depth of the present cut by 2 feet would require the excavation of about 3,000 cubic yards of earth. This work, together with the construction of a temporary dam around the head of the canal, permitting dry digging, and the construction of a plank dam with movable top at the bayou end, would not cost more than $1,500. This is far less than the cost of adding 2 feet to the height of lock and dam over that necessary for giving the required navigable depth.

The canal lies entirely within the limits of the Keystone plantation, and I was assured by the owner's agent, Mr. Peters, that no difficulties would be placed in the way by Mr. Pettibone, the owner, but that all encouragement would be given to the enterprise.

Near the west end of Spanish Lake is found the head or mouth of Bayou Tortue, sometimes an outlet, sometimes an inlet. Another ditch connects the lake with the bayou at a point about 2 miles below the Keystone Ditch. This has, however, nearly ceased to carry water. The lake seems to be fed by springs which drain a considerable area of land. I believe its use solves the question of water supply in a certain and inexpensive way. The canal enters the bayou at a point about 2 miles above that provisionally selected by Assistant Engineer H. C. Collins as the site for the lock. At the point selected, there is at low water about 6 feet depth, but between this point and a point 9 miles further down-stream the bottom rises in many places, so that an excavation of about 26,000 cubic yards would be required to give a depth throughout this 9 miles as great as that at the proposed lock site. Below this stretch the bottom does not rise appreciably higher than at its lower extremity, at which point it is nearly at the same level as at the upper extremity. There is little to determine selection of a site, save this consideration of bottom level. The banks are at almost uniform height above the water; the chief variation in cross-section is caused by the fact that it is sometimes the right, sometimes the left, bank which approaches most nearly to the bayou, while the distance between their crests remains about the same.

The shoalest water below Saint Martinsville is near the Keystone Bridge; the lock should be placed somewhere below this extensive shoal. There is a point about half a mile lower, where the water is 2 feet deeper than at the bridge; Mr. Pettibone's plantation is on one side, Mme. Delahoussaye's property on the other. Both these parties would act reasonably, if not generously, toward the enterprise. The site is well suited to lock-construction. At a point about 2 miles lower, however, is the point heretofore proposed, and except that the riparian owners are rather hard to deal with, is better suited than the upper point, in that the bottom is about 1 foot lower. The riparian owners, when questioned about the matter about two years ago, demanded $1,200 and $1,000, respectively, for a strip about 1,000 feet long and 50 feet wide, measured, I presume, from low-water mark. The width of these strips is scarcely as much as would be desirable during construction. The prices asked are much more than the land is worth. Of course all difficulties with riparian owners may be avoided by condemnation of the desired property. As before stated, there is at a point about 9 miles further down-stream another favorable site. The bottom is here nearly a foot lower than at the point last considered. The advantage to be had here is that no dredging need be done, as all the bars rising higher than the sill of the lock would be up-stream and boats of heavier draught could reach the lock.

So far as initial expense is concerned, the cost of a slight increase in height of lock and dam would probably be offset by the money saved on dredging. But it should be remembered that even if dredged down to-day, the bars would probably reform in the course of a few years, while, if left up-stream of the lock they cease to be troublesome, certainly for many years. Cross-section 222 of the survey of 1882, taken from the locality considered, is plotted and submitted herewith. In this case I have supposed the lock to be placed outside the low-water line, inside the high-water line. The slope of the bank is such that for a lock rising to 10 feet on the gauge the whole space occupied be excavated. In this way a large area is added to the flood waterway, permitting the construction of a considerable amount of permanent dam without diminishing the cross-section. Although the height of lock and dam is, in the present discussion, considerable less than was before supposed, yet this height, rather the area between crest of dam and bottom, is so large a fraction of the whole flood area that it is still important to make a part of the dam movable, or to supply increased area in time of flood by large sluices. The advantages of the movable-dam system



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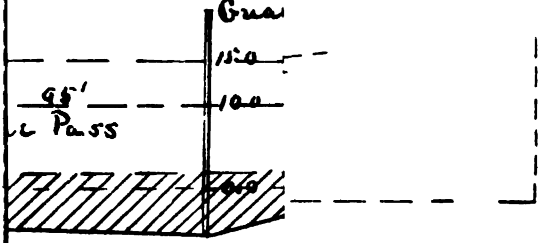

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have already been shown, in the case referred to. In the case now considered I give data, first, under the supposition of a combination of permanent and movable dam:

Area added to water-way by lock excavation	square feet	750
Area subtracted from water-way by permanent dam	do	730
Volume excavated for lock, 80 by 20 by 400 feet	cubic feet	640,000
Volume excavated, upper approach, 50 by 15 by 400 feet	do	300,000
Volume excavated, lower approach, 50 by 15 by 400 feet	do	300,000
Volume excavated for permanent dam, 200 by 3 by 20 feet	do	12,000
Volume excavated, total	do	1,252,000
Volume excavated, total	cubic yards	46,370
Volume masonry, lock-wall and bays, 15 by 6 by 800 feet	cubic feet	72,000
Volume masonry, floor and foundation, 80 by 5 by 400 feet	do	160,000
Volume masonry, permanent dam, 10 by 730 feet	do	7,300
Volume masonry, foundation dam, 200 by 2 by 20 feet	do	16,000
Volume masonry, total	do	255,000
Volume masonry, total	cubic yards	9,455
Length of movable dam	feet	95
Height of movable dam	do	9
Height of permanent dam, average	do	3.6
Double row sheet-piling across bayou	do	260
Lumber feet, 260 feet by 3 inches by 6 feet=1		4,680
Lumber feet, in 12 inches by 12 inches grillage under lock-floor		234,000
Weight of masonry, at 140 pounds per cubic foot (concrete)	pounds	28,850,000
Weight of lockful of water	do	14,400,000
Weight of grillage	do	585,000
Weight of gates and connecting iron	do	175,000
Weight of movable dam and attachments	do	100,000
Weight, total	do	43,610,000
Number of piles for foundation		700
Average load piles not assisted by earth	pounds	62,200
Feet of coffer-dam		500
Cost of 9,455 cubic yards concrete, at $10		$94,550 00
Cost of 24,000 feet cypress lumber, at $15 per M		3,600 00
Cost of 700 piles driven, at $8 per pile, driven		5,600 00
Cost of 46,370 cubic yards earth excavated, at 25 cents		11,592 00
Cost of 95 feet movable dam, at $100		9,500 00
Cost of two sets gates, at $5,000		10,000 00
Cost of iron bolts, &c		1,000 00
Cost of 500 feet coffer-dam, at $15		7,500 00
Cost of lock-keeper's house		1,500 00
Cost of land near lock		1,000 00
Cost of labor not above estimated in cost material		30,00 00
		148,842 00
Add 20 per cent. contingencies		29,768 40
Total		178,610 40

To change this estimate to that for the case of permanent dam throughout and excavation on the side for increased water-way, we substract 95 feet movable dam, at $100	$9,500
And we add—	
7,407 cubic yards excavated, at 25 cents	1,852
588 cubic yards masonry (concrete), at $10	5,880
	7,732

Or we reduce first estimate of $148,842 by $1,768, making it $147,074, practically the the same. The excavation of 74.07 cubic yards earth is to gain about 1,000 square feet cross-section occupied by the movable dam, now replaced by permanent structure; a sloping approach above them 200 feet long, and a slope below the dam 100 feet long, prevent an eddy otherwise to be expected in a sudden widening. This cut is filled only at high water, the upperend not being cut through the natural bank. The small difference in cost, even if no excavation were made, is more than offset by advantage of having a wide navigable pass during high-water seasons.

The thickness of lock-floor was determined by the formula,

$$E = \frac{-l^2 + l\sqrt{l^2 + 2h}\,P}{P}$$

in which E = thickness of concrete floor, l = width of lock, h = lift of lock, and allowable pressure on square meter of concrete; the linear elements all in me This formula gives 6.8 feet as thickness of concrete. As I have supposed the conc to be laid on a solid grillage of 12 by 12 feet timber, this dimension is reduced. formula is intended to give a large result; it is taken from De Lagiemé. Length head and tail bay walls are from Rankin's formulas; the thickness of chamber-w is found by the ordinary formulas for retaining-walls. Thickness of the dam is pl at such a figure as to leave a large safety margin beyond the known pressure. cost of movable dam is based on figures taken from reports of Major Merrill, Corp Engineers; the Chanoine wicket is contemplated, but should further study greater fitness in some other type, the cost would not probably largely vary fro timates. The Chanoine wicket will certainly answer the purpose, but is not sugge as absolutely the best for the purpose. I will insert here a short calculation, wh should have appeared above, showing the effect of a permanent dam in raising flood-surface near the dam. The formula used is taken from Trautwine and is proximate only. Increased height above dam = height of natural flood-surface ab crest of dam

$$+\sqrt[3]{\frac{(\text{Flood discharge})^2}{7\times(\text{length of dam})^2}}$$

As has been seen, the flood discharge at 15 feet on gauge is about 8,250 cubic per second. Suppose 3,250 cubic feet pass through the open lock; then, the dam be at 10 feet on gauge increased of height $= 5 + \sqrt[3]{\frac{5000^2}{7 + 350^2}} = 8.1$ feet; hence a 15- flood would be combed up to 18.1 feet on the gauge.

The weight on the piles, 30 tons, is, under the circumstances, a safe load. A stra of blue clay, I am informed by Mr. Burbank, formerly State engineer, is found 3 feet below the bayou bottom, overtopped by sand. In the estimates made this is supposed to be removed. In this blue clay the piles would be driven, and on clay would rest the floor. In case of a monolithic structure, such as that propo it might be thought that distribution of pressure of so large an area would ren unnecessary a pile foundation.

A French authority, Minard's "Navigation des Rivières et des Canaux," says, der the heading "Soil incompressible, but liable to scour, sand, gravel," &c.: "Fo directly on the soil, and give the floors a thickness of from 2 to 6.5 feet, dependi upon the lift, the width of the lock, and the tenacity of the masonry." Major rill, after quoting the above, says, Report of Chief of Engineers, 1875, II, 622: "T great difficulty occurs in the lock-chamber. Although we may, by using sheet-pili greatly reduce the percolation of water through the soil under the lock, it is impo ble to stop it entirely. The effect of this under current of water is to cause an upw pressure on the floor of the lock whenever the chamber is empty. This upward pr ure must be met by dead weight or by weight aided by tenacity. If we use noth but concrete it will resist partly by its weight and partly by its construction as a mo lith with its ends firmly held under the side-walls. If we fill the area with piles a less amount of concrete in the spaces between the piles we will then have a res ance due to the weight of the concrete in water, increased by the resistance of piles to extraction." Following this is his recommendation of piles and platform which the concrete floor is placed. This he calls the French method, and he pref it to that of putting the concrete below the platform (a method sometimes used in country), because the concrete may sink into voids caused by settlement or otherw thus becoming detached from the piles and from the under surface of the platfo leaving the latter to sustain alone the upward thrust. I belive if the grillage sisted of two layers of beams, the lower resting on the heads of piles, level with ground, the upper at right angles to the lower and bolted to them without being into each other, or if at all only 3 or 4 inches, and the concrete laid on the grou under and around and above this upper layer of grillage-beams, that both timber masonry would act always together in bearing both up and down pressures. Or if one layer of timbers be used, with intervals, and resting on the heads of piles about 1 foot above the earth floor, the concrete being laid on the earth and built to a proper thickness, a bond would be formed which would, as before, develop resistance of the piles against strains, up or down. By this means the thicknes concrete could safely be diminished below that required by De Lagrómé form As it was my desire to make a perfectly safe estimate, I have adhered in all cases large rather than merely safe dimensions. I believe that study in detail would velop the possibility of lower prices in several elements of the construction, but in this preliminary study I give only what seems to me figures that will not disappoint by proving too small. Thus it may be found that brick would be cheaper than concrete in the construction of the lock-walls.

A thousand brick will lay about 1.6 cubic yards of masonry, which will weigh about as much as an equal quantity of concrete, the bricks being best pressed quality. They can be laid for $5 per thousand, and would now cost about $25 bought here and delivered. A cubic yard would then cost about $18. I believe this figure might be rendered by having the bricks specially made at or near the site of the lock. Bricks are made all along the Teche, but, so far as I know, none of extra quality. It is fair to presume that, since the proper soils are found near Saint Martinsville, bricks of desired quality might be made at less cost there than they could be had transported from a distance. Ordinary *hard* brick, such as are used for pavements in this city, if bought here, would cost when laid at Saint Martinsville about $12.50 per cubic yard. Bought in the country such brick would cost about $8 per cubic yard laid. But masonry of such brick has less specific gravity than concrete. When dead weight is a consideration, the cost of the structure would, therefore, be the same as, or greater, in brick than in concrete. The cheapest construction would doubtless be of timber, so far as initial cost is concerned. But the greater cost of repair and the shorter life of such a lock make it advisable to incur, then, greater initial cost of masonry. What has been said of the lock masonry, is also true of that part of the permanent dam, not topped by the movable—namely, that a change of material *may* result in an economy in the construction that the saving will not be great.

From the foregoing I draw these conclusions:

First. Water enough to supply any deficiency in the bayou itself may be had from Spanish Lake.

Second. This water can be had at a cost of about $1,500.

Third. The best position for the lock is at a point about 14 miles below Saint Martinsville, because, (*a*) all dredging is avoided; (*b*) a slight increase of possible draught is obtained.

Fourth. Part of the dam should be movable, because (*a*) a wide navigable pass is made available at high water; (*b*) it offers the best means of retaining the normal cross-section at flood stages.

Fifth. A horizontal line drawn the 10-foot mark of the Saint Martinsville gauge is 5 feet higher than the bayou bottom at Arnaudville; hence the crest of the dam should be held at that height.

Sixth. The foot of the movable dam should be held at or near the zero of the Saint Martinsville gauge, thus permitting uninterrrupted navigation when the gauge reads 6 feet. The water having its natural slope at this reading, 5 feet can be carried to Arnaudville.

Seventh. Lock and dam can be built for about $175,000, the masonry being wholly or largely of concrete.

Eighth. This estimate of cost may be too large, but it is not too small.

Ninth. The estimates of dimensions may in many cases be reduced by more detailed study; they would rarely be increased.

Tenth. A lift-wall, rising to 4 feet on the gauge, can be built at the upper end of the lock, thus diminishing cost of upper gates and cost of excavating upper approach.

I had intended to include in this report some study of the general relations between velocities in different parts of the cross-section of a stream. As these matters are not necessary to the discussion of plans for the lock, consideration of them will be presented separately.

Very respectfully, your obedient servant,

O. T. Crosby,
First Lieutenant, Engineers.

Maj. W. H. Heuer,
Corps of Engineers, U. S. A.

R 6.

CONNECTING BAYOU TECHE WITH GRAND LAKE AT CHARENTON, LOUISIANA.

The project was adopted in 1880, the object being to connect Bayou Teche with Grand Lake at Charenton by a canal a little over a mile in length, 5 feet in depth, and 50 feet wide at bottom. Careful examination of the locality developed the fact that the difference in water-lev between the Bayou and Grand Lake was variable and as much a feet 4 inches, and that in the event of a narrow or 50-foot cut the cur- rent would be so rapid as to probably scour the banks unless a lock w interposed, but that if a cut 100 feet wide at bottom be made the lo could be dispensed with.

The cost of the 50-foot canal with lock was estimated to be about same as the 100-foot canal without the lock, and the latter would very much more desirable and cost much less for maintenance.

March 3, 1881, Congress appropriated $25,000 to commence this w the estimated cost of which was $75,000. It was shown that the c of the work, if done by construction or purchase of plant and hi labor, would be much less than if done by contract. The amoun money available would not warrant the commencement of the work either plan; hence the actual work of digging or starting the canal not yet begun.

The land on which the canal was to be dug and cession of juris tion were given to the United States, the necessary surveys were m the level lines run, lines located, and tide-gauge observations were lated, plotted, and studied.

This, together with the necessary engineering and office expenses volved a cost of $2,899.95. Should the canal ever be cut it would of local importance and shorten the transportation route of rafts of from Grand Lake into the Teche by about 75 or 80 miles.

It is not thought it would benefit steamboats plying on the T (the richest sugar country in Louisiana) or the planters to any great tent, for the reasons that the plantations are on the bayou, the sup must go up the bayou and the products of the plantations must down the bayou, and thence by the regular rail or water routes to Orleans. In my judgment it would be much better to defer starting canal until it is known definitely what disposition is to be made by Mississippi River Commission of the head of the Atchafalaya Ri Any changes in this now very important stream will affect the w levels in Grand Lake and Bayou Teche, and may require a chang the whole project for the canal. As the money appropriated will make a through cut, and therefore not benefit navigation or comm to the slightest extent, and if done by contract will cost fully one-t more than if a contract could be made for the full cut, it is rec mended that no work be commenced on this canal until the am necessary to complete the same, viz $75,000, has been appropriated becomes available; nor is it supposed benefits to commerce will eq or approximate what the canal will cost.

Money statement.

July 1, 1885, amount available	$22,10
July 1, 1886, amount available	22,10

Amount (estimated) required for completion of existing project	50,0
Amount that can be profitably expended in fiscal year ending June 30, 1888	72,10

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

R 7.

IMPROVEMENT OF BAYOU BLACK, LOUISIANA.

Examination of this bayou was ordered by act of Congress of June 14, 1880. Preliminary examination was made in January, 1881, and a partial report made February 2, 1881, full report being prevented by the failure of the employé who made the examination to submit report, though frequently directed to do so. On March 3, 1881, $10,000 was appropriated for this work.

With the annual report of 1881 was published a full report of a preliminary examination made by an assistant engineer, in which the condition of the bayou, as indicated below, was clearly represented. Appropriations made in 1882 and 1884 amount to $25,000.

In an inspection of this bayou made in April, 1885, I made notes and observations, and on them base the following report and deductions:

From the village of Tigerville to the spot where the dredge is at work, about 10 miles above, the Bayou Black has now a depth of 5 to 6 feet of tide-water—the width of this water-way varies from 45 to 100 feet.

The greater portion of this 10 miles has been worked over by the dredge, and the last 4 miles is practically a canal in the bed of the bayou, which has been dug by the dredge. As fast as the digging progresses the ditch or canal which is being dug becomes filled with tide-water, but that portion of the bayou in front of dredge is so filled up with sediment, grass, logs, roots, and stumps, and contains so little water, that at present it is impossible to float the lightest skiff.

When the examination was made in April, 1885, and resulted in a stoppage of the work, principally because the appropriation was about exhausted, I doubt if there was 50 gallons of water per minute flowing in the bayou, and a few days before this the ground in front of the dredge was so hard that it became necessary to hire 4 mules and a plow to break the ground so that the dredge could work.

In fact, following the rank, tall grass growing in the old bed of the bayou is the practical method of tracing its course.

From the point where the dredge has now stopped working to the town of Houma *via* the line of the bayou (the proposed improvement) is 14 miles in length. The bed of the bayou is filled up with mud and obstructions very nearly to the level of the roads on each side of it; so that to complete the work contemplated will yet practically require the digging of a canal 45 feet wide by 6 feet deep by almost 14 miles in length.

The muck, &c., thrown out of the canal is so oozy or semi-fluid that much of it will run back into the canal, and it is probable that a pile and timber revetment may have to be built over a considerable portion of the route to prevent this.

On each bank of the bayou is a wagon-road 25 to 40 feet in width, just beyond which are the fences of plantations and small farms. The muck must therefore be thrown on the road, obliterating that on one side, perhaps on both, and making either of them for the time being almost if not entirely impassable.

When the canal, or ditch, shall have been completed to Houma it will enable small boats (probably flat-boats) to carry sugar and the material products of the country from the plantations bordering on the bayou from Tigerville to Houma, an extreme distance of about 24 or 25 miles.

The estimate for completing this improvement, by Major Howell, in 1881 was $47,520; of this amount nearly $25,000 has been expended, of which about $4,500 was used in part payment for the building dredge-boat now in use in cutting the canal. This would leave $20,0 expended in actual dredging about 10 miles of bayou, a considera portion of which was already open bayou, and between 14 and 15 mi of bayou yet to be opened; the average quantity of material to be moved in each mile of cutting, I estimate to be nearly double wha was in the preceding 10 miles already opened, and therefore estima the cost nearly twice as much, or $4,000 per mile. As there are about 14 miles of cut to be made, the estimate for completing this should be 14×$4,000=$56,000. This, together with the $25,000 pended, would be $81,000, an excess of $33,480 over the original mate for completing the work. It is barely possible that this estim for completion may be too great, but when the sunken, imbedded lo stumps, roots, thrown up by the dredge all along the embankment seen, no prudent engineer would submit a smaller estimate, and I warranted in saying that no contractor would make a contract to do work required even on this estimate. Moreover, in pushing the wo to advantage, the engineer in charge of this improvement has never timated less than $10,000 to be necessary for any one year's work.

Suppose the remaining 14 miles were cut to Houma. Here, by opening an old canal, now deteriorated into a shallow ditch, connecti may be had with the Bayou Terrebonne. The cut is about 1 mile lo

Suppose this done and the Terrebonne improvement completed this point also, the result would be that planters along the Black Terrebonne could use these connected canals (for such would bayous be) to get their products to the railway station, whence by to New Orleans, about 70 miles, or to ship by water through Bay Terrebonne and Black, Bayou Chêne, Bayou Bœuf, Atchafalaya Riv and Mississippi River to New Orleans, about 400 miles.

It is reasonable to suppose that the railway rates for carrying frei less than 70 miles should be less than that of water routes nearly times as long. The advantage to the planter in having the improve trade is, therefore, simply the saving in cost and time to him in mansportation or hauling his product from his plantation by wago by canal to the nearest railway station. On or near the Bayou Black, 25 miles apart, are two railway stations, Tigerville and Houma; the fore, the longest haul to nearest station would be 12½ miles, or an av age haul of 6¼ miles. Is the Government justified in cutting a ca for that is just what is being done in improving Bayou Black, the lo estimated cost of which is $47,520, for the sake of saving to the pla the difference between 6¼ miles of wagon and canal transportation?

The improvement at its best is simply a local one and only bene the people living on or near the bayou, and can in nowise be conside a public necessity, but as it has been begun by authority of Congr and $25,000 has been spent on it, if the work were now stopped th greater portion of this money would be wasted. It is therefore assum that the work will be continued to completion, and in this event no le than $10,000 should be appropriated for the fiscal year ending June 1887.

It must be distinctly understood that while I do not recommend th Congress appropriate $10,000 for the year's work because it will bene the Government or the people in and near Bayou Black to this exte it is simply because, in an engineering point of view, this is the lea amount of money that can be advantageously expended in doing ec nomical work, provided Congress intends to continue this improveme

During the past fiscal year the dredge-boat for this work was hir to a private contractor, by order of the honorable the Secretary of War. It was used on Red River, Louisiana, and rent received for same for 116½ days, at $20.00 per day—total, $2,330.00. This amount was credited to the appropriation for Bayou Black, and permitted the repair of the dredge.

The boat has been lying at Morgan City, La., since it was returned by the contractor, December 2, 1885. Here the repairs have been made by hired labor and purchase of material in open market. The dredge is now in fair order. All repairs have been made that are necessary to enable the dredge to be set to work.

Money statement.

July 1, 1885, amount available	$427 68
December 5 and 12, 1885, amount received for rent of dredge-boat	2,330 00
	2,757 68
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	2,825 87
July 1, 1886, amount available	431 81
Amount (estimated) required for completion of existing project	56,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

R 8.

IMPROVEMENT OF BAYOU COURTABLEAU, LOUISIANA.

The original project, made in 1879, contemplated (1) the closure of a number of outlet bayous on the south, or right bank of the stream, for the purpose of cutting away Little Devil Bar, near the mouth of the Courtableau; (2) the construction of locks and dams, carrying slack-water navigation to Port Barré (17 miles above the mouth) by the first set and to Washington (28 miles above the mouth) afterward.

The estimated cost of the work was $40,000, afterward increased to $78,500. Subsequent investigation as to the probable cost of lock-construction in this section of the country lead me to believe that even this second estimate is too small.

As appropriations became available several dams were built across outlet bayous, and the result was a very marked deepening of the bar at the mouth of the bayou, by as much as 3 feet in two days.

One of these dams was afterwards reported cut by the swampers, with whose logging operations it may have interfered; the result was that in 1884, immediately after the dam was opened, the bar shoaled as much as 4 feet.

During the fiscal year 1884–'85 a quarter-boat and flat-boat pile-driver were built for use on this bayou. High water prevented their use until August, 1885. Work was then begun, following plans submitted by Captain Turtle in a letter dated November 28, 1884, and containing explanation of conditions originally existing. (See report for last fiscal year.)

The construction of two dams was accomplished, one at Little Fordoche, under Lieut. C. T. Crosby; and one at Big Fordoche, under

Superintendent C. D. Anderson. The construction of the former was interfered with by a sudden rise. The completion was hastened; but the rise continuing, the dam gave way the day after it had been thought complete. Work was resumed on it and continued until again nearly water-tight. Large amounts of willow brush were placed between rows of piles, and weighted with bags of earth, and loose earth when the current had been sufficiently checked to permit its use. The scouring of the current after the break permitted round piles to be driven into clay, which had before been almost impossible with the sawed stuff ordered for conditions existing at Captain Turtle's examination. Since that examination considerable shoaling had taken place, due probably to the remains of old timber dams supposed to have been cut, and the increased depth of sand rendered pile-driving very difficult. Steamboat-men, who have recently passed that point, report that water is still running over the dam, though, as was anticipated, the outlet bayou has nearly filled up, and the bar which before lay just below the Little Fordoche is now quite above it.

The dam at Big Fordoche was strongly built in clay foundation and remains in position. Lumber was bought for the commencement of a third dam, but funds having run too low for further work, the plant and lumber were stored in December, 1885, since which time no work has been done.

At the date of this report it is impossible to make an examination of present condition of the dams and bar, since the water is very high. As it seems probable that important changes in the regimen of the Atchafalaya will soon be attempted, I do not now recommend any appropriation for the Courtableau for the fiscal year 1887–'88. Any appropriation that may be made this year by the bill now pending may perhaps be wisely expended in endeavoring to give immediate relief, following places already presented or modifications that may be suggested by an examination, to be made as soon as possible. Recommendations for future appropriations can be much more intelligently made after this examination has been made and something definite is known concerning the future of the Atchafalaya.

Money statement.

July 1, 1885, amount available	$3,892 [illegible]
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,553 [illegible]
July 1, 1886, amount available	338 [illegible]
Amount appropriated by act approved August 5, 1886	5,000 [illegible]
Amount available for fiscal year ending June 30, 1887	5,338 [illegible]
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	12,107 [illegible]

R 9.

IMPROVEMENT OF BAYOU TERREBONNE, LOUISIANA.

No work has been done in this bayou during the past two years owing to a lack of funds.

An examination of this stream was ordered by Congress in 1879. A project for improvement was made in 1880 at an estimated cost of $18,800, of which about $15,000 was to be for dredging, the balance for removing logs, clearing of trees, &c.

The commerce to be benefited by the improvement, principally sugar and molasses, was estimated at an annual valuation of $958,750. In 1880 an appropriation of $10,000 was made; with this a dredge was hired, and work was commenced 23½ miles below Houma, La., working up-stream. In March, 1881, $8,800 more was appropriated.

The hired dredge improved about 8½ miles of channel, and in 1881 stopped work about 15 miles below Houma. The examination for improving the bayou was made during high water, and was found to be altogether too small in amount, as during low water it was seen that the bayou was little more than a ditch. The estimates for improvement were accordingly increased by Major Howell, the officer then in charge, by $20,000. With part of the money available from money appropriated for this work and part from Bayou Black appropriation a dredge was built to continue this work. The Terrebonne appropriation paid $5,262.70 toward the building of the dredge. In August, 1882, $7,000 more was appropriated for continuing this work, and in September, 1882, work with the new dredge was commenced and continued to within 10½ miles of Houma, when the funds became nearly exhausted, and further work had to stop.

No appropriations have since been made, and consequently no further work has been done. The channel was originally dredged to a depth of 6 feet, but nearly every plantation on the bayou has ditches draining into it; these cause deposits in the bayou, and opposite these numerous ditches it has again shoaled up until the depth is only about 4.8 feet.

One or two very small steamboats run up to Houma when there is any business for them, and the project was to carry the improvement up to Houma, there connect with an old abandoned canal, about a mile long, now dry, with wagon-roads crossing each end of it, which canal formerly connected with the Bayou Black. Should this and the Bayou Black work ever reach the opposite ends of this short canal, which was about 33 feet wide, then it was hoped this would be deepened, and enable the tides to flow regularly through both bayous and the canal, and maintain by its flow a better depth of water by preventing the rapid growth and accumulation of grass and vegetable matter.

Should any further appropriation be made the work of dredging will be continued toward Houma. It is thought the work can be completed to this place for the $13,000 estimated for in 1881–'82. If this improvement, and that of Bayou Black in connection therewith, be completed, they will be reasonably permanent and of some local benefit to this section of the State of Louisiana.

The commercial value of the products raised on the Bayou Terrebonne is estimated, when the crops are good, at a little less than $1,000,000 per year, and it was reported prior to a year ago that the improvement had occasioned competition and a reduction of freight rates in this locality of about 25 per cent.

Money statement.

Amount appropriated by act approved August 5, 1886	$10,000 00
Amount (estimated) required for completion of existing project	3,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	3,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

R 10.

IMPROVEMENT OF BAYOU LA FOURCHE, LOUISIANA.

The original project for this work was adopted in 1879, from surveys authorized by act of Congress March 3, 1873 (see Report of Chief of Engineers for 1874, Appendix S 5), the object being to improve low-water navigation of the bayou by removal of obstructions, such as snags, wrecks, raft heaps, cutting of trees, &c., which obstructed navigation.

On account of high water, operations were suspended December 31, 1881, and resumed September 21, 1882. From this time till January 31, 1883, the work was carried on steadily to a point 30 miles below Lockport, when, the funds being nearly exhausted and the water getting too high, the plant was taken to Lockport and laid up.

In the river and harbor act of August 22, 1882, provision was made for a survey of this bayou.

A preliminary report on this was forwarded on August 30, 1882, and in Department letter of April 24, 1883, it was directed that the survey should be made.

No work was done during the year ending June 30, 1884, the balance of available funds being too small to permit anything more than the payment of a watchman for the care of the boats.

On August 25, 1884, an amended project was submitted by Captain Turtle for continuing work downward from where it had been suspended the previous year, and authority was received from the Chief of Engineers, under date of September 1, 1884, to carry on the work as recommended.

The work of overhauling the plant at Lockport was immediately commenced, and work was resumed September 22, 1884, and continued until January 15, 1885, when it was again stopped on account of high water and the plant ordered back to Lockport and the crew discharged except the suboverseer and cook, who were retained for further service on Bayou Teche. The plant was at the same time placed under the direction and orders of First Lieut. O. T. Crosby, Corps of Engineers. By authority of the Chief of Engineers it was removed to Bayou Teche, serving, *en route*, as a quarter-boat for a survey party on Bayou La Roupe. It has remained on the Teche since March, 1885, engaged most of the time in snagging and wrecking operations.

After completion of the survey of 1883 a study of the level-notes showed them to be worthless. Without an accurate profile no plan could be made; hence in April of this year, 1886, I directed Lieutenant Crosby to rerun the level-line. His report on this work, covering also consideration of plans of improvement, is appended. The commerce of Bayou La Fourche has been greatly benefited, the number of vessels having steadily increased as the obstructions were removed. Before any work of improvement the bayou was so obstructed with snags, logs and wrecks, from its head at Donaldsonville to a point about 22 miles below Lockport, that during the low-water season flat-boats and luggers drawing about 2 feet were the only kinds of vessels able to navigate. In some places, especially between Raceland and Lockport, a distance of 7½ miles, even this was difficult, the luggers having to lower sail and cordelle. But since the removal of obstructions flat-boats and sailing vessels of even greater draught have passed up and down without difficulty. During eight months of the year, when the water is high, the bayou is navigable for large-size steamboats.

Lieutenant Crosby's report is full of detail. Of the plans suggested for the improvement of the navigation of the bayou, that by means of a lock at Donaldsonville, and dredging out the bayou below where required, so as to make a tide-water canal of the bayou, having a channel 5 feet deep by 75 feet wide, estimated to cost $450,000, is very decidedly preferable to any or all of the others.

In an engineering point of view, this plan is perfectly feasible, and the estimates are believed to be reasonable.

The estimated cost of making the improvement is $450,000, with an annual estimated expenditure of $8,000 for operation and maintenance.

The interest on $150,000, at 5 per cent., is	$22,500
Add the cost of maintenance	8,000

We have in round numbers the equivalent of an annual Government expense of, say, $30,000 to keep the Bayou La Fourche navigable.

Lieutenant Crosby has shown in his report that the amounts paid last year for freights to move the crops on the La Fourche were approximately $100,000; that for the three or four months that the bayou was low, the increased cost of freight in consequence of having to handle it in flatboats was $19,000.

It would be absurd to claim that the cost of transportation would be any less in consequence of a lock at Donaldsonville than it is at present in an ordinary navigable condition of the bayou, which obtains, say, during eight months of the year; therefore if the lock and slackwater navigation is to produce any decline in freight rates, it must be during the low-water season when ordinary steamers could not run. The additional freight cost in consequence of low water during the present year has been estimated at $19,000. Under these circumstances the Government would not be warranted in expending $30,000 per year for the sake of saving $19,000.

The commerce of the bayou is estimated to have a value of little more than $3,000,000 per year. The improvement will cost $450,000 to complete, and $8,000 per year to operate and miantain. Should the project be adopted by Congress, the entire appropriation should be made at once, because dredging and construction of lock should proceed simultaneously. The lock without the dredged channel would be useless, and a dredged channel without the lock would soon refill.

Money statement.

July 1, 1885, amount available	$1,244 55
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	989 94
July 1, 1886, amount available	254 61

REPORT OF LIEUTENANT O. T. CROSBY, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., June 11, 1886.

SIR: I have the honor to report as follows upon the work of running an accurate line of levels down Bayou La Fourche, Louisiana:

In obedience to orders from you, I went to Donaldsonville, La., the point where the La Fourche leaves the Mississippi, on April 26, 1886.

The party, as organized here, consisted of 8 men, viz, Lieut. O. T. Crosby and United States Assistant Engineer T. L. Raymond, observers; 2 rodmen; 2 helpers; 1 boatman; 1 cook. We were quartered in a small hired boat, which was floated down stream to the end of the line, and towed up stream, on completion of the work, to Raceland, where it was delivered to its owner.

Before leaving the office I had provided myself with a description of a permanent bench-mark placed by a Coast Survey party some years ago on the east bank of the Mississippi, about 1 mile above Donaldsonville. Figures given in Mississippi River Commission reports enabled me to refer this bench-mark to mean Gulf level, as determined by the Commission's gauge at Biloxi. This was of considerable advantage, as it would have been impossible to obtain at the mouth of the La Fourche any reliable information as to any plane of the Gulf—mean low, mean, or mean high—which would be given as closely as this plane of mean tide of the Gulf at Biloxi.

Work was begun on this Coast Survey bench-mark, the line being taken across the river by repeated observations from both sides. The separate determinations made by Mr. Raymond and by myself, when corrected for curvature of the earth, were very close in spite of the length of the shot; moreover, the water-surface itself afforded a good check, as the transfer was made across a straight stretch of the river, where the elevation of quiet water on opposite sides must have been the same to a very small fraction of a foot. The line was then run to Donaldsonville, and from that point, over the same ground followed by the party of 1883, to Orange, La., a point 84 miles below Donaldsonville and 23 above the mouth of the La Fourche. This point was also the terminus of the line run in 1883, whose inaccuracy rendered it useless and made necessary the work just done.

Along this line a total of 191 bench-marks had been left, an average of nearly 2⅓ per mile. Of these we identified and corrected about 150, an average of nearly 2 per mile. This made it unnecessary to repeat the hydrographic work, which had been carefully done, since any point in any cross-section of the bayou whose elevation might be of value in making a plan of improvement can be referred to the nearest corrected bench-mark. The whole error in the old line is about 4 feet, and it is a regularly increasing error from beginning to end of the 84 miles; as only about one three-hundredth of this error would be introduced in referring a cross-section to a corrected bench-mark one-fourth of a mile distant (the average interval between corrected bench-marks being about half a mile), this error must lie far within the ordinary limits of error in hydrography. Had hydrographic work been attempted it could not have been done at the present high stage of the river with half the accuracy attained in 1883, when work was done at low-water stage.

The method adopted in leveling was as follows: Each observer read both back and fore sight two or more times, the rodman calling out the reading, which was repeated until a satisfactory mean of several observations, differing from each other by only a few thousandths, was obtained. The rodmen remained in their places, holding their rods on the same peg, until both observers had made separate determinations of the difference-level between the two pegs, had compared these determinations and found that they closely agreed. In case they differed, the observations were repeated, instruments adjusted, observations again repeated, until satisfactory agreement was obtained. This method places a severe check upon accidental and constant errors, both personal and instrumental. It saves time, inasmuch as all errors discovered by it may be corrected before leaving the spot where committed. In saving time it of course saves money. It tends to prevent that voluntary or involuntary forcing of results which sometimes occurs when the correction of an error would prove to be a fatiguing, lengthy process. During the progress of the work an error in the graduation of level-tube scale was discovered. The scale is marked on a small brass bar, placed above the glass tube of the bubble, and is marked on both sides of the bar. In this marking a double error exists: First, on both sides of the bar, marks of the same numbered value, counting from the center of graduation and on opposite sides of that point, are found at unequal distances from it; second, these discrepancies are not the same on opposite sides of the bar. The first error is slight, and if it were the same on both sides the bar would be eliminated when back and fore sights are equal, no matter which side of the bar be observed in leveling. Not being the same on both sides, it became necessary to observe the same side in leveling for both back and fore sight. A discrepancy of about 0.2 foot between Mr. Raymond's elevation and mine existed when this was discovered. After this discovery our determinations were never more than 0.06 inch apart, exclusive of the above amount, and on the last bench-mark—in other words, on the whole line save the few miles run during the growth of the error of 0.2 foot—our difference was but 0.011 foot. Such closeness of result, attained by two independent lines, *every shot* of each having been checked by the corresponding shot of the other, certainly entitles the work to be called "precise leveling"—a term applied in Mississippi River Commission Reports to the best work required or done. Both the instruments used are quite old, their screw-threads much worn, consequently much more time was consumed in obtaining reliable observations than would be necessary with good instruments. In doing similar work the cost of a new instrument would soon be covered by saving of time. The use of umbrellas, protecting the instruments from sun and wind, permitted the use of much time which, without such protection, must have been wasted. The total cost of the survey was —— or —— per mile.

With this report I respectfully submit a profile of the bottom of the bayou and top of east levee, together with all high and low water marks obtained, and all corrected bench-marks, this profile plotted to same horizontal scale as the topographic work, and on same sheets; also another profile of bottom and levee-top, on smaller scale and on a single sheet, with typical cross-sections. The plotting was done by Mr. Raymond, the fidelity and intelligence of whose service both in the field and in the office you are already so familiar with that special mention of them here is unnecessary. Both in the obtainment of data and in the preparation of the report his assistance has been of the greatest value.

The commercial interests to be affected by an improvement of Bayou La Fourche will be understood from the following statements. The total value of agricultural products raised along the banks of the La Fourche during the season 1885-'86 was about $3,200,000, of which about $2,900,000 must be ascribed to sugar and molasses, the remainder to rice, potatoes, and miscellaneous products. It may be stated with sufficient accuracy, that the Southern Pacific Railroad Company controls shipments of products from the parish of La Fourche; this parish produced crops of the value of about $1,100,000, leaving $2,100,000 for the parishes Assumption and Ascension. The railroad freight rates do not vary with the stage of the water, since at all seasons freight transported by rail is gathered from the plantations by large flat-boats, the running of which is rarely, if ever, interfered with by low water.

When the water in the bayou has reached a stage so low as to prevent the entrance of large steamboats from New Orleans, products seeking shipment from the upper part of the bayou are taken by flat-boat to Donaldsonville, thence by steamboat or Texas and Pacific Railroad to New Orleans. Captain Drown, secretary of the company owning the largest steamboat interest in the bayou, informs me that this flat-boat service causes an average increase of about 40 per cent. over high-water rates. The ordinary (or high-water) rates are: one hogshead sugar, $1.50; one barrel sugar, 35 cents; one barrel molasses, 75 cents; one sack rice, 25 cents.

The $2,100,000 given above for the upper La Fourche represent about 30,000 hogsheads sugar, 50,000 barrels molasses, 30,000 sacks rough rice. On these goods freight at above rates would be $90,000. From figures furnished by Captain Drown, I find that about 9,100 hogsheads of sugar, 17,000 barrels of sugar, 26,000 barrels of molasses, 10,000 sacks of rice must have paid the 40 per cent. increase, thus making the freight bill of the upper La Fourche for outgoing products $109,000 instead of $90,000.

This excess of $19,000, capitalized at 5 per cent., represents $380,000. No other figures of definite value can be presented as showing the benefit derivable from an improvement that would permit through navigation all the year round. In addition to this should always be accounted the value a free water-way always has in checking monopoly prices. Whether such value in this case be large or small, I do not venture to guess, since it is a matter dependent upon the disposition of the Southern Pacific management. Just now the people along the lower as well as the upper part of the bayou are enjoying the benefit of a very lively competition between steamboats, resulting in a cut-down to one-quarter of railroad card rates. This has continued for some weeks, but it is not thought that it can continue long. The trips of the largest boats are now at times extended as far as Harang's Canal, 68 miles below Donaldsonville, while usually they go no further than La Fourche Crossing, 38 miles below Donaldsville. Some of those with whom I conversed claimed that the steamboats would be able to conduct a much more beneficial competition with the railroad, were it not for the two or three months' interruption during low water, an interruption which usually occurs when the sugar crop is beginning to move and transportation arrangements for the whole crop may be made.

These statements relative to competition with the railroad apply only to that part of the bayou below Napoleonville, a point 16 miles below Donaldsonville. Above that point, low-water improvement, besides giving relief from the flat-boat charges, might extend competition among steamboats, as against each other. From Mr. H. O. Maher, wharf-master at Donaldsonville, I obtained the following statement:

"When the Bayou La Fourche is navigable from December until about the first of August, the steamers Assumption, Isabel, E. W. Fuller, and Alice LeBlanc make two trips a week (each) to Thibodeaux and La Fourche Crossing, sometimes extending their trips as far as Lockport. The steamer Hélène is now making trips on alternate days between this place (Donaldsonville) and Thibodeaux, frequently extending her trips to Lockport, or even further. She is a passenger boat." There are four railroad stations on Bayou La Fourche, one at Donaldsonville, one at Thibodeaux—the terminus of a 3-mile branch line from Terrebonne Station; one at La Fourche Crossing, and one at Raceland. The first, that of the Texas and Pacific, seems, from its position at the upper extremity of the bayou, to be but little considered as a competitor with the steamboats. The other three, belonging to the Southern Pacific system, having advantage of position (34, 38, and 49 miles from Donaldsonville, respectively), and having accessory flat-boat lines constantly running, commands a large trade. I was informed that even the flat-boat service on the upper bayou must be suspended and wagons resorted to for carrying freight to Donaldsonville. In such case the excess over ordinary is much more than 40 per cent. The calculations presented have covered only out-going freights, because I learn from Captain Drown that, at all stages of the La Fourche, in-going freight is billed from New Orleans at ordinary rates, of which at low-water season the steamboat retains two-thirds, and renders one-third to the flat-boat for delivery beyond Donaldsonville. That there may be cases in which an increase of charge occurs I do not doubt, as several parties on the bayou so informed me; but Captain Drown thinks that ordinarily the flat-boat contents itself with the one-third card rate. No definite figures for this increase could be reached, hence its omission above. Two other commercial elements, having a value too indefinite for accurate numerical expression, but sometimes very great, remain to be mentioned, namely, certainty and speed in the delivery of goods. It can only be said that both these are injuriously affected by the interruptation of through steamboat transportation.

The difficulties, from an engineering point of view, may be understood from the following statement:

The Mississippi at Donaldsonville not unfrequently reaches a low-water surface elevation of about 2 feet above mean low water of the Gulf. The bottom of the bayou at the Donaldsonville Bar is about 2.5 feet above the plane of mean low water of the Gulf; is nearly as high on other bars found here and there throughout the first 30 or 40 miles, and is frequently up to that plane (mean low-water Gulf) throughout the same distance. A comparison of the data recently obtained with statements in Humphreys and Abbot's Report indicates that these conditions have long existed, practically without change.

In the 30 miles just above the Gulf, however, considerable change is said by old residents to have taken place within the last fifty years. Although the information on this point was not as definite or reliable as I wished to obtain, there was yet sufficient to show that a considerable shoaling has taken place, beginning at the bar beyond the mouths of the La Fourche and extending at least 25 miles up-stream. This has been accompanied by an increased elevation in the general land-surface near the bayou. It is shown in Humphreys and Abbot's Report, page 455, that in 1858 the land-surface on the left bank, 12 miles below Lockport, was about 4 feet above mean Gulf level. It is now about 6.5 feet. A short distance below that point, about 15 miles below Lockport, the levees are now, and have been during the last three high-water seasons, cut in many places by the land owners with a view to increase the elevation of their lands by alluvial deposit. Crossing to the right bank, our levels show that an elevation of 4 feet is reached at a point about 23 miles below Lockport, while five miles farther down it is 3 feet. At this point I was informed by a man who has lived there for fifty years, the bayou had shoaled from a depth of 30 to a depth of 15 feet, and has diminished in width also. He stated that a proportional change had occurred farther down, and that he knew the outside bar had largely shoaled since his residence on the bayou. Making large allowance for exaggeration of statement, there are corroborative facts showing change. Humphreys and Abbot reach the conclusion that the land-surface probably reaches Gulf-level at about the point above referred to, and make no mention of inhabitants near the Gulf. Now the slight ridge running parallel to the stream is inhabited almost to the shores of the Gulf, and I was informed by one living below Lockport that these people had come from other points within comparatively recent years, indicating that the land has only recently been cultivable. Besides the old resident above alluded to, another informant, a man of intelligence, stated that during an acquaintance of about ten years with the lower bayou he too could remark a change—a decrease of cross-section. It is also stated by Humphreys and Abbot, page 455, that the levees at Harang's, 12 miles below Lockport, were only 3 feet high in 1858. In 1883 they were about 6 feet high; but 6 miles lower down they were only 3.5 feet high. Adding the increased height of levee to increased height of land, we find an increase of about 5 feet in elevation of levee-top at Harang's, that elevation being now about 12.5 feet, referred to the Gulf. Three miles below the cut-off the land has an elevation of about 4 feet, which, added to the height of levee, places the levee-top at 7.5 feet above the Gulf. That such a rapid fall should exist now, the levee being cut just below the cut-off, is readily understood; that it existed before is explained by the fact that previous to the high water of 1884 the right bank was quite neglected, its levees, as shown by the survey in 1883, being lower than those on the left bank, which was under cultivation, the high water often escaping over the right bank, and sometimes intentionally let through it in order to relieve the left, caused the land on the right side to gradually increase its elevation above that on the cultivated and protected side. The inhabitants, realizing its greater value, and desiring to build up their old fields, moved their work across the bayou, improved the levees there, and gave up the left bank to the waters, using it only as the waters subside for the planting of a small crop of rice. It is thus seen that the levee system has never been an efficient protection against large lateral flow farther down than a point about 13 miles below Lockport.

In their decision of the La Fourche, Humphreys and Abbot discard what they call the

"Explanation usually offered to account for the necessity of constantly raising the levees in the lower part of the bayou." This common theory, as stated by them, was that, where the levee terminated, the waters of the bayou overflowed the banks and raised them by deposit. The current of the bayou being diminished by this escape of water, a deposit was also made in its channel. This deposit contracted the waterway and increased the lateral overflow, and thus accelerated the elevation of the natural bank. This has had the effect of backing up the bayou above and thus raising the flood level.

Instead of this explanation, they advance the theory that the constant rise of flood level is due (1) to the fact that the lower bayou having had, before the building of the levees, a cross-section large enough for carrying only the income at Donaldsonville *minus* the lateral overflow permitted by low, natural banks, is now too small to carry freely, without temporary damming up of a part, the whole amount entering from the Mississippi; and (2) to the fact that the extension of the levees caused a temporary increase of flood heights for certain distances above the point where extension begins, the local slope being, of course, much diminished by such extension and height thereby increased. That the first of these causes would produce, at points somewhat distant from the Mississippi, immediate increase of flood height consequent upon the first building of levees, need not be doubted. But Humphreys and Abbot also state that "levees were commenced at an early day, and were extended rapidly down one-half the length of the bayou." "In 1842 the levees terminated at or a little below Lockport, 56 miles below Donaldsonville, and 54 miles above the Gulf. In 1859 they nominally extended 27 miles below Lockport, although it is stated they were not more than 3 feet high, 12 miles below that town." It has already been seen that they are effective now only as far as the cut-off, about fifteen miles below Lockport. How, then, could the second cause operate, when there has been practically no extension of levees; and to what shall we attribute the large increase of levee elevation, shown to have taken place at Harang's, and to what shall we attribute "the necessity of *almost* annually raising their levees," a necessity complained of generally by the planters near to and above Raceland, as reported to Major Howell? (See Chief Eng. Rep., 1874, Vol. I, p. 767.) Evidently the first cause could not produce a constant increase of flood height, observable through many years succeeding the establishment of the levee system; evidently, also, the second cause has been in operation only to an insignificant extent. Some other cause must have operated to produce the increased flood heights. In Major Howell's report, above referred to, it is stated that the planters claim that the gradual filling in of the bayou between Raceland and the cut-off produced the increase.

This is substantially a repetition of the "usually offered explanation" referred to by Humphreys and Abbot, the placing of the lower limits, the cut-off being in all probability due to the fact that all could see the growth of the great longitudinal bars near that point (and which now appear as islands, even at high water), while few took account of the shoaling below, which still left ample depth for navigation. That some obstruction other than smallness of natural cross-section existed below Lockport is noted by Humphreys and Abbot in a foot-note, page 455: "It has also been suggested as an additional cause of the rising of the high-water level that the bayou below Lockport is chocked up by rafts and tow-heads. * * * Lieut. Henry L. Smith, Corps of Engineers, who examined the obstructions below Lockport in 1853 with a view to their removal, states that they begin about 5 miles below Lockport, and consist of a great number of snags, which project above low water, and for the distance of 18 miles almost entirely prevent the passage of steamboats during the low water of summer and autumn. Such obstructions must, of course, retard the flow of the water and to some slight extent raise the flood-level for a limited distance above them, but they are evidently inadequate to aid materially in producing the constant increase of floods throughout nearly the whole bayou."

All the snags appearing above low water have been removed during the last few years by parties working under the direction of this office, but many remain imbedded under the deposit, the local growth of which was hastened by the presence of the logs. The current maintains a channel on either side of these islands, but their presence largely diminishes the cross-section.

The facts above, showing clearly an annually progressive decrease of cross-section in the lower bayou, were not known to, and were disputed, by Humphreys and Abbot. The knowledge of them leads inevitably to the conclusion that the theory presented by Humphreys and Abbot, is unsatisfactory, and must be supplemented by the "usually offered explanation," this itself to be supplemented by some emphasis upon the fact that the shoaling begins at the very mouth of the bayou.

The eminence of the authority stating that "neither excavation nor deposit has been made in the bed," and the importance of the matter in considering a plan for permanent improvement, made it necessary for me to go to some length on this point.

Seeing now that a considerable portion of the sediment received by the bayou is deposited at its mouth, in the Gulf; along its overflowed banks, and on its bottom in the region of overflow; seeing, in short, that the La Fourche is not in its regimen an exception to other sediment-bearing, annually-overflowing, tide-reaching streams, we will be prevented, while searching for a radical cure for existing evils, from falling into an error which might follow the application of the theory quoted above from so high an authority as Humphreys and Abbot's report.

The following plans have been suggested by different persons for improving Bayou La Fourche.

First, by dredging alone.—In order to secure a depth of 5 feet at extreme low water, with a channel width of 75 feet, the following volumes must be excavated.

	Cu. yards.
From Donaldsonville to Napoleonville, 17 miles	460,000
From Napoleonville to Thibodeaux, 17 miles	270,000
From Thibodeaux to Raceland, 16 miles	80,000
From Raceland	1,000
A total of	811,000

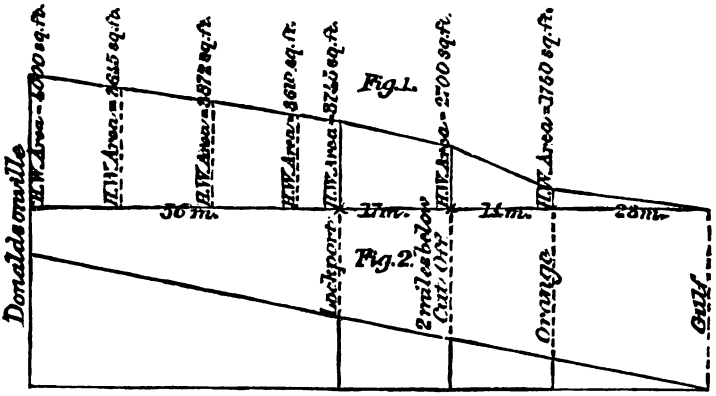
This calculation supposes the central depth to extend over the width of 75 feet, 37.5 feet on each side of the thread of the stream. The result therefore probably errs by being somewhat too small. That part of the bottom covered at low water is, however, quite flat. At 20 cents per cubic yard the cost of this dredging would be $162,000. (Recent dredging in Mobile Bay is reported at 12 cents per yard. But for a new work, in a less convenient locality, and for which annual appropriations would probably not be large, it would not be safe to estimate on so low a figure.) A channel having been thus obtained, the conditions would be thus—at low and medium stages a somewhat larger volume of water would enter from the Mississippi.

As the river rose this somewhat larger volume would the sooner fill the now insufficient cross-section in the lower bayou; this cross-section and the head of water at Donaldsonville being unchanged, the high-water volume would be reduced to its former value; this volume flowing, where dredging was done, in a larger channel, would have diminished velocity, causing deposit from water highly charged with sedimentary matter. This general action would be locally hastened where unusual widening of the levees would cause sudden expansion of the flood volume, or unusual contraction cause sudden damming. The tendency would thus be to return to that condition of equilibrium which had been disturbed by the dredging. If, however, the benefit to navigation originally secured might continue until the volume excavated had been nearly or quite restored by deposit, the expenditure for dredging might still be a profitable one, since many years *might* elapse before complete restoration; but local irregularities of channel would, in all probability, soon produce, here and there, deposits equal to those removed. Especially might we look for early restoration of the Donaldsonville Bar. The gradual deterioration of the lower bayou and extension of that deterioration up-stream, would, of itself, destroy hope of securing a permanent improvement by dredging. An improvement costing about $165,000, and without guarantee of longer life than one season, could not wisely be undertaken for this bayou.

Second plan.—To dredge, as explained above, and to extend the levees to, or nearly to, the Gulf. The cost of extending an efficient levee system to within 8 or 10 miles of the Gulf would be about $125,000, at 20 cents per cubic yard. This amount, added to the estimate for dredging, gives a total of about $287,000.

By a proper regulation of the width between such levees and the excavation of irregular batture and island formations for use in building the levee, an approximate uniformity of cross-section and of perimeter, at high-water stages, would result: The effect of such works upon the navigability of the stream can be inferred from a study of the changes of surface slope that would be produced. Fig. 1 shows the high-water slope as it now is; in the 56 miles above Lockport there is only twice as much of fall as in the 13 miles below it, and scarcely as much as in the 18 miles below the cut-off. It is in this last stretch that the great lateral loss through cut levees occurs.

Fig. 2 shows the slope, that the confinement of the whole flood within a channel would tend to produce—namely, a uniform slope. After the proposed dredging the bottom would also have a more uniform slope than now; hence both changes would tend to uniformity of surface slope. In the first section (see figures) above the Gulf, about 22 miles long, the change would produce an increase of slope, hence of current, hence of transporting or scouring power. But this increase would be felt for but a short distance, if at all, in the Gulf. The only effect on the bar would be an increase in the quantity of sedimentary matter for deposit. The increased current might carry this sediment a little further gulfward than now, but in the end the increased deposit would again seriously obstruct the outflow, raise the flood level near the Gulf, thus diminish the velocity, and cause a precipitation of suspended matter in the channel. Regularity of cross-section and of velocity would be disturbed, the disturbance gradually proceeding up-stream, causing increase of flood-height above it, due to backing



up of the waters that no longer find sufficient cross-section for easy flow. This raising of flood-height would be equivalent to a decrease of slope and velocity in the section above. This would finally produce some deposit above; but, on the other hand, since the total head between Donaldsonville and the Gulf is constant (approximately so), decrease of velocity in an upper must be accompanied by increase of velocity in the lower section. Hence deposit then would cease, or perhaps excavation occur, until local uniformity of slope would again be approached, only to yield again to another change, these oscillations continuing until such size and form of cross-section had been reached as would cause annual excavations to equal annual deposits in the bed, the whole mass of earthy matter then being deposited in the Gulf producing extension of the delta formation. A slow decrease of average slope per mile would result, the appreciable effects of which, however, are so distant that we need not now consider them. The sediment annually discharged into the La Fourche would cover one square mile to a thickness of about 1 foot. A few miles beyond the mouth of the La Fourche the Gulf has a depth of 300 feet. The bar in front of the two mouths is several miles long; hence no rapid growth into the Gulf need be feared. Again referring to the figures it is seen that in the second section, between Orange and the "cut-off," extension of levees would produce diminished slope. As the high-water velocity here is now very great, it is not probable that the decrease would result in any material change of the bed. The velocity would still be equal to that now existing in many places without causing deposit. In the next section above—that between Lockport and the cut-off—the velocity would remain as it is, very nearly, but the flood-heights would be considerably diminished. Above Lockport there would be an increase of velocity, and a general decrease of flood-heights. It has been shown before that dredging throughout this section, without changing conditions along the lower sections, would be soon followed by a re-establishment of present conditions throughout. But, having secured an increased velocity, it follows that this restitution could not so readily occur. In the existing state the current is such as to leave the bed of the bayou almost unchanged from year to year. The dredged channel might then be maintained until modification of the immediate gain of velocity due to the changes outlined in discussing the lower or Gulf section of the bayou—this modification due to disturbances originating at the Gulf—would be slow in reaching as far up as Thibodeaux. Thus in the Mississippi, while we see rapid changes of bed near its mouth, traceable to changes at and beyond the mouths, and changes at the Forts and above that are traceable to local causes. There is doubtless a slow change throughout the river, due to changes at the Gulf, but it is not appreciable. Deterioration of the dredged channel in the La Fourche would then be looked for as due to local causes. Since there is practically no caving of the banks these changes would be few as compared to the number in the Mississippi, and would be due to slight, perhaps only temporary, irregularities of cross-section, which would operate to build up and remove changing bars. Therefore, while it is not probable that the great shoals now extending for miles throughout this section would reappear, it is probable that here and there a bar would be formed, impeding navigation. These might be removed by dredging or by the construction of wing-dams, as experience might direct. The Donaldsonville bar would certainly recur, as the plan considered would have no appreciable effect there. That bar is caused by the existence of a body of nearly dead water on both sides of the line dividing the current of the Mississippi from that of the Lafourche.

In any plan which would give security against recurrence of all other bars save this, it would be advisable to construct special works for its destruction, as by building jetties, which would throw the dividing line out into the Mississippi; but in the plan now considered some dredging would probably have to be done annually. Hence the additional expense of controlling this bar would be small as compared with the initial cost of special works and the incidental cost due to inconvenience of exit and entrance for the many large flat-boats that float in and out of the bayou. It is impossible to present with the initial cost ($287,000) of executing this plan any close estimate of annual cost of maintenance. If we suppose that as much as 5 per cent. of the total annual amount of transported sediment be deposited where now, with less current than the improvement would obtain, a very much smaller quantity is deposited, then $10,000 per year would cover the maintenance by dredging. During some years it would probably be unnecessary to spend a cent.

If the interests of navigation *alone* be considered, it is certainly questionable as to whether such expenditures would be warranted. Two other great benefits would result—comparative freedom from danger of overflow and the addition of many acres to the cultivable area along the bayou. Consideration of these important matters might therefore lead one to recommend this plan to a State government, which looks to *all* the interests of the people, while refusing to recommend it to the United States Government, whose concern is with only certain specified interests.

Third plan.—To construct a lock at Donaldsonville and to convert the bayou, by dredging, into a navigable arm of the sea. To dredge a 75-foot channel down to 5 feet below mean low tide would require the removal of 1,600,000 cubic yards of earth. This amount is so large that in the event of its being done lower figures than those used in the first estimate above could be obtained. At 15 cents per cubic yard the cost would be $240,000. Since the water supply is practically unlimited, the form of lock may be made similar to that at the head of company's canal, near this city. In this lock the leveed banks would be the side walls, save that length of side wall required for abutments and gate-chamber. Such a lock, 200 feet long and 30 feet wide, was estimated, in a report to Major Howell, 1875, to cost $115,000. Increase of length would entail small additional cost; so of increased width, which saves some side filling, increases cost of end walls only by difference between cost per linear foot of gate and wall, and requires a few hundred additional cubic yards of concrete for the floor. These items of increase will be covered by $45,000; adding $30,000 to cover what I consider as shortages in the 1875 estimates we have $190,000 as the cost of a lock 300 feet long and 50 feet wide.

The total for this plan is then $450,000; to this should be added $8,000 per year for operating and maintaining the lock and removing deposits which would occur just above and below it. Supposing the average number of lockages per day to be 10, there would be annually admitted into the canal about 10,000 cubic yards of sediment. The great value of this plan, aside from the aid given to navigation, is the security given against floods—more than that, relief from the necessity of keeping up any levees whatever.

The saving to the people in this way may fairly be added to the saving on freight in estimating the advantages of the plan as an instrument for the Government. How much is annually spent on repair of levees I do not venture to say, as it is a very variable quantity, but it probably amounts to some thousands of dollars annually. There should also be considered an annual average loss due to occasional crevasses. These items have a positive and present value, though difficult to express. I feel confident that this value, increased by $19,000 saving on freight, and diminished by $8,000 cost of lock maintenance, would give a sum which capitalized at 5 per cent. would equal the initial cost of the improvement. There is a further and larger gain than this, that larger efforts would be made as soon as the ever-threatening fear of overflow is removed. From many opinions expressed to me by planters I believe this plan is much preferred by them to any other feasible one. Many of them answered my inquiries in this way: "Yes; of course we want navigation all the year; but what we most want is relief from high-water dangers." Considering all its advantages, slackwater navigation all the year, relief from levee expenses and loss by crevasses along the new cultivated portion, increase of acreage further down, and general inspiration to effort due to freedom from overflow, might, in my opinion, be very wisely undertaken by the State. Should the concern of Congress extend to *all* these interests, it would likewise be a proper undertaking for the General Government. The extent of Congressional concern in the matter of land reclamation has varied considerably.

The disadvantages of the plan are, the slight detentions incident to all locking works, the necessity of abandoning the present system of irrigating rice fields, and the cessation of all sedimentary building up of the low lands near the Gulf. Rice fields are now irrigated through flumes cut into the levee at low water. During high water there is, of course, sufficient head to cover all the fields. Should this industry be pursued after execution of the plan considered, it would be necessary to irrigate by pumps, as is now done along the Teche. As there are now a great many rice planters, the experse involved in setting up steam-pumps would be considerable, and the annual expense of running them would doubtless be $25,000 or $30,000. Were they secured against floods, however, I believe many of these people would be glad to abandon rice, or in this security against floods would consider themselves compensated for the increased expense, if rice culture were continued. There is a contingent benefit derivable from this plan in this, that it would facilitate the endeavor to open any of the several canals that have been built up to the La Fourche levees, but connection never made on account of the expense of locks. At Lockport, the terminus of company's canal, a lock was built, and afterwards destroyed by a crevasse. It was never opened. Harang's Canal has never been opened. The State "cut-off" has never been opened. All these would furnish most desirable lateral communication with New Orleans. They are not large enough to carry steamboats such as those now trading on the Upper La Fourche, but a considerable part of the potato and fruit crop is now handled by luggers, which have a circuitous route, inside or outside. It was confidently stated to me that private enterprise would certainly open these canals, or one of them, if the cost of lock construction were reduced to a very small sum, as it would be by this improvement.

Fourth plan.—By adding to that just considered, a movable dam, placed at the side of the lock.

This is, of course, feasible, and as there would be but 50 or 60 feet of such movable part it would not be a costly work. It would, however, require one complete side-wall to be built for the lock, which would materially increase the cost of that structure.

It would require a much larger amount of dredging, and, without constant and costly regulation, might subject the less prudent inhabitants to the danger of overflow, since even the restricted discharge of the Mississippi might raise the water surface up to or above the level of the lower lands. It would cause the admission of floating logs, which would become obstructions. The advantage gained would be the relief from the necessity of locking during three or four months of each year. The initial cost would exceed that of the other plan by not less than $60,000. The annual cost of maintaining the dredged channel would be very much increased, since a much larger amount of sediment would be introduced. Near the lock a dangerously strong current would be produced. Of the two plans, the former is, in my opinion, preferable.

Fifth plan.—By placing a lock or dam at Donaldsonville, and one at Lockport, and introducing water in the basin thus formed from Lake Field, lying 1 mile west of Lockport. This plan is referred to simply because it has been discussed by engineers of reputation in the State. The discussion, however, is based upon the erroneous reports of some persons (private surveyors, I believe), to the effect that the water in a small canal cut from the lake toward the bayou, stands 7 feet above low water of the bayou. This lake is a drain for swamps west of the La Fourche. At the time of the survey of 1883 its water was about 2 feet above mean low tide of the Gulf, and, from information obtained by a recent personal examination of the lake, I learn that this elevation was not probably its lowest water. Its level is subject to rapid variations due to rains, but during low-water season of the La Fourche is usually about as low as that stream. The plan is, therefore, not worthy of further consideration.

Sixth plan.—By purchasing and completing company's canal. This canal is cut from a point opposite the upper part of this city to Lake Salvador, east shore; from west shore of Lake Salvader to Bayou La Fourche, at Lockport. The lock at the Mississippi is in use; that at Lockport is in ruins. In order to accommodate boats such as are now in the La Fourche trade, both locks, and the whole length of the canal, about 8 miles, would require enlargement, at very great expense. The locks would practically be rebuilt. The upper (most valuable) part of the bayou would be little benefited without dredging. The effect of dredging, without construction of a lock at Donaldsonville, has already been studied. With a lock at Donaldsonville, the other lines become only a convenience, not a necessity. As a convenience, replacement of the small lock at Lockport might be a paying investment, as before stated, while to purchase and enlarge would be entirely too expensive.

Seventh plan.—To construct wing-dams throughout the shoal region. As an adjunct to the plan of dredging and levee building, these constructions have already been referred to. To construct as many of them as would be required for producing navigable depth throughout the many miles of shoals would be a very expensive work; in a stream whose low-water width is but 80 or 90 feet, it would be, if not impracticable, certainly dangerous; it would only hasten deterioration in the lower bayou; it might require expensive dredging in the beginning; without levee building its effect would probably be only temporary, as shown in discussing the first plan; it has not the incidental advantage of securing against floods, or of adding to the cultivable area.

Of these seven plans, I believe that of converting the bayou into a salt-water canal connected with the Mississippi by a lock is the best, and that it would pay an imaginary private owner of the whole La Fourche country to execute it.

I believe that no appropriations will be required during the next few years for making such temporary amelioration as has recentlybeen obtained.

The obstructions will doubtless re-form, but as yet obstructions of the kind referred to—snags, overhanging trees, &c.—are not serious.

Very respectfully, your obedient servant,

O. T. CROSBY,
First Lieutenant of Engineers.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

R 11.

IMPROVEMENT OF CALCASIEU RIVER, LOUISIANA.

The work originated in an act of Congress approved June 14, 1880, authorizing an examination.

The original examination of this river was made only down to Lake Charles. A subsequent examination was made of the lower part of the river at its mouth, in Lake Calcasieu, report of which will be found in Annual Report of Chief of Engineers for 1883, Appendix Q. Further inquiry was made in December, 1884, report on which appeared in Report of the Chief of Engineers, 1885. The result of these investigations may be briefly stated. No work is needed above Lake Charles, La., the only town on the river. Below that point the first work to be done is the removal of a bar at the head of Calcasieu Pass, connecting Calcasieu Lake, into which the river empties, with the Gulf. The facts leading to these conclusions have been fully set forth in previous reports. Two appropriations—one of $10,000, the other of $6,500—have been made for this river. Of this only a small sum for examinations and office expenses has been expended. The bar in the lake being the point at which beneficial work must be commenced, and this bar having been separately appropriated for under the head of "Calcasieu Pass," it was construed by the Chief of Engineers that sums appropriated for the river were not applicable to work on the bar without Congressional sanction. Such sanction has not yet been given; hence the inaction. My only recommendation at present, therefore, is that such sanction be given.

The annual cut of lumber around Lake Charles, La., is worth about $800,000, about half of which is transported by rail, east or west, from Lake Charles. Within the last few years this industry has ceased to be, as it was formerly, almost the sole occupation of the inhabitants of the Calcasieu Valley. Agricultural lands are beginning to be taken in considerable quantities, but no definite figures can be given as to value of products.

Money statement.

July 1, 1885, amount available	$16,255 46
July 1, 1886, amount available	16,255 46

R 12.

IMPROVEMENT OF CALCASIEU PASS, LOUISIANA.

In 1874 a channel was dredged through the bar or flats at head of Calcasieu Pass. This cut refilled, and in 1881–'82 was again dredged through for a distance of 7,500 feet; a channel was made 8 feet in depth and 70 feet in width. This work was done by contract, at a cost of $10,444.

The total appropriations for this work to date have aggregated $30,000, of which $27,074.75 have been expended on the improvement.

The latest information from this locality indicates that the dredged channel over the bar has again refilled to its normal condition before dredging, viz, 3½ feet of depth.

Both channels which were dredged over this bar were cut across the shortest line of the bar, were to a certain extent experimental, and urged by commercial and navigation interests, so as to get immediate results. Since these cuts refilled so rapidly, a cause for this deterioration has been sought for, and it is believed to be partially due to the waves and currents passing between the lake and the pass not acting in the line of the cut, and also due to the small number of steamers using the cut. As the directions of the seas and currents are to a great extent governed by the winds, and these are variable both as to direction and intensity, no channel can be excavated on the bar which shall at all times have the currents and seas flowing in its axis, and therefore be subjected to some fill; but it is thought that, if a cut be made across the flats more nearly in the direction of the prolongation of the axis at the head of the pass than the old cut was, the filling would be less rapid than formerly.

This improvement is now in an unfortunate condition, owing to the wording of the act making appropriation. Heretofore this bar has been dredged upon from the appropriation for "improving Calcasieu Pass," which was clearly applicable to this work, but two later appropriations were made for improving "Calcasieu River," without specifying any particular locality for improvement, and it is not known that appropriations for improving the river can be properly applied to the improvement of the pass. It is certain that the improvement of the river proper is of no use so long as the present bar obstructs navigation at the pass. Should it be decided that money for the river can be applied to the bar at the pass, then work could go right ahead, as the money available for the river, together with that for the pass, would enable an effective channel to be cut at the pass, and any balance could then be used for whatever might be required in the way of improvement higher up-stream. But to spend public money for improvement up this river with the bar at the pass unimproved would be a waste of public funds. As the funds certainly available for the pass are not sufficient to do any work there, no work has been done on either the pass or the river during the past fiscal year.

If it be decided that funds for the river can be used for the pass, or if further appropriation be made for the pass, then a careful examination will have to be made as to which line the proposed cut shall be made upon. It is thought the cut will cost about $16,500.

The commerce of the pass is entirely dependent upon that of the river, and the latter is estimated to have an annual value of $528,000.

Money statement.

July 1, 1885, amount available	$2,925 52
July 1, 1886, amount available	2,925 25

R 13.

IMPROVEMENT OF SABINE PASS, TEXAS.

The object of the improvement is to obtain deep water over the bar at the entrance of the harbor. In 1878 and 1880 channels 12 feet deep were dredged across the bar at a cost of about $167,000. Both soon refilled.

In 1882 it was proposed to get deep water here by means of two jetties, each a little less than 4 miles in length, extending from shore out across the bar into deep water of the Gulf, at an estimated cost of $3,177,606.50.

In August, 1882, Congress appropriated $150,000 for this work. With this and an unexpended balance from former appropriations work was commenced in 1883 by contract on one of the jetties, and 188,552 cubic yards of jetty were built.

In July, 1884, Congress appropriated $200,000 more for this work, new contracts were made, work was continued on the west jetty and commenced on the east jetty and continued until August 26, 1885, when in consequence of scarcity of funds work had to stop. At this time the east jetty foundation was 11,190 feet long, and the jetty itself was built nearly up to the level of the mean high tide for a length of 188.40 feet, or a little over 2 miles.

Foundation of the west jetty was built out to a length of 16,074 feet, and of this jetty 6,710 feet, commencing at the shore-end, was raised about the level of mean high tide. The jetties were built entirely of brush and stone.

During the past fiscal year work on the jetties was only done during July and a part of August, to complete the contract entered into during the early part of 1885. The foundation of east jetty (40-feet wide) was extended 990 feet and the top of the jetty (15-feet wide) was extended 2,140 feet; 5,710 linear feet of west jetty were raised above high tide and 562 linear feet beyond this were raised to mean low tide.

On June 30, 1885, one year ago, no result in increased depth of water on the bar or inside were apparent; since then three surveys have been made, which show a least depth of 8 feet of water on the bar, where we formerly only had 6 feet.

The inner and outer bar curves of 9 and 10-feet depths are gradually approaching each other, showing a marked improvement in the channel. In other words. during the past year, as closely as we can estimate from actual surveys, a scour has taken place on the bar at Sabine Pass of a little over 1,000,000 cubic yards of material. The depth of water on the bar has increased fully 2 feet, being a gain of 33 per cent. in depth, from incomplete jetties not yet extending over the rest of the bar.

On June 14, 1886, a cyclone struck Sabine Pass; the damage to the jetties amounted to the loss of about 3,000 linear feet of top mattress on each jetty; the total loss, as nearly as can be estimated, is about $23,000.

Thus far about $500,000 have been spent on this Jetty project; it has built about 3⅓ miles of jetty to the level of mean high tide, and a foundation-course considerably longer.

The jetties are just beginning to produce beneficial results, which can only be continued by pushing both jetties rapidly beyond the crest of the bar. One million dollars could be expended profitably in the fiscal year ending June 30, 1888.

There is no commerce worth mentioning at Sabine Pass; it is prospective, and depends upon the results of the contemplated improvement.

The work has been in local charge of Assistant Engineer Thomas L. Raymond, who has done all his work in a most thorough and satisfactory manner, and who has furnished the following detailed data of work done during the year.

At the close of the last fiscal year, the construction of the two jetties under contract with the Louisiana Jetty and Lightering Company was still in progress, and in the annual report then submitted a detailed account of the character of the work and the methods employed was given, there having been built during 1885 to July 1st of that year 10,200 linear feet of the foundation of east jetty, 8,700 feet of which had been built up to high tide by the addition, where necessary, of top mattresses 15 feet wide; on the west jetty there had been placed during the same period 1,000 feet of mattresses 10 feet wide.

From July 1, 1885, to the close of the contract on August 26, 1885, the foundation of east jetty, 40 feet wide, was extended 990 feet, and the top work, 15 feet wide, was carried to a point 350 feet from the end of the foundation, or a distance of 2,140 feet beyond its terminus on July 1, 1885.

The west jetty, during the same time, was raised above high tide for a length of 5,710 feet, and to mean low tide for a distance of 562 feet beyond the former work, being 15 feet wide and the latter 20 feet wide.

To sum up: At the the close of the contracts of 1885 the east jetty foundation was 11,190 feet long, and nearly up to mean high tide for a distance of 10,840 feet, in the construction of which there had been used 8,890$\frac{157}{224}$ tons of stone, and 664,364 cubic yards of brush. The west jetty foundation, built in 1883, was 16,074 feet long, 6,710 feet from the shore, having been raised to mean high tide. In 1883 there were used in this jetty 14,465 tons of stone, and 104,088 cubic yards of brush, and in 1885 there were used 2,386 tons of stone and 11,353 cubic yards of brush.

SURVEYS.

Three surveys, previously reported upon, have been made during the past fiscal year; the first in September, 1885, the second in January, 1886, and the third June 23 and 24, 1886; a chart of the last is herewith submitted.

These surveys show a continuous improvement in the depth since the construction of the east jetty, resulting in the present channel of 8 feet depth at mean low tide across the bar, which assures a navigable depth of 9 feet into the pass at the ordinary daily high tides. Appended to the chart is a comparative profile of the present channel and that existing at the time of the inauguration of the present work of improvement. This profile shows an increase in depth since 1881 of 4 feet near the beginning of west jetty, the gain diminishing to 2¼ feet opposite the end of east jetty, while as far as 2,500 feet beyond that point the increase in depth is 1 foot.

A comparison of contours of equal depths shows the following improvement:

The 6-foot contour, through which there was in 1881 a channel 550 feet wide and 6.1 feet deep, has been obliterated between the jetties and their prolongations 2,300 feet wide.

The 7-foot contours, 3,000 feet apart in 1881, have also disappeared between the jetties and over the bar.

The 8-foot contours, 7,800 feet apart in 1881, do not now close, there being an 8-foot channel across the bar 220 feet wide, with a maximum of 8.2 feet.

The 9-foot contours, 9,000 feet apart in 1881, are now 5,500 feet apart, a gain of 3,500 feet.

The 10-foot contours, 9,700 feet apart in 1881, are now 7,000 feet apart, a gain of 2,700 feet.

A calculation of the amount of scour and fill which had taken place at the time of the January survey of 1886 shows that to that time there had been removed from between the jetties and their prolongations 1,161,000 cubic yards, against a fill over a portion of this area beyond the end of east jetty of 158,000 cubic yards.

CONDITION OF THE JETTIES.

Since the completion of work under the last contract, Sabine Pass has been visited by two severe storms, from both of which the jetties suffered, but the last, on June 14, was an exceptionally destructive cyclone. During this storm the water rose to a height of 4½ feet over that portion of the town of Sabine Pass between the railroad embankment and the pass, destroying the wharves, 3 warehouses, and 4 dwellings, and washed out 10 miles of railroad track and parts of the embankment.

On the accompanying chart are longitudinal sections of both jetties, showing original heights and those found at the date of the recent survey after the storm.

The damage indicated on these sections is confined to the top course of mattresses, the outer 3,000 feet of each jetty having lost the top course entirely, the loss diminishing gradually towards the shore, the inner 4,000 feet of the east jetty and 3,000 feet of the west jetty having suffered but little.

As the top course was only 15 feet wide, the loss of material is not commensurate with the loss in height, and as near as can be estimated the loss of material amounts to about 12 per cent. of the amount placed in the work during 1885.

TIDES.

From June 1, 1885, to January 1, 1886, a self-registering gauge was in operation, situated in the pass 2½ miles above the end of east jetty. A comparison of the record of these months with that of the corresponding months of 1881 shows that while the mean low-tide elevation for this point remained the same for the two periods to within 0.01 foot, the mean high-tide elevation, and therefore the mean range of tide, was less after the building of the jetties during the latter period by 0.32 feet, equal to 23 per cent. of the total mean range. This indicates that the capacity of the inlet for tides would require further enlargement by scour or otherwise before the normal tidal conditions should be restored. The injury to the jetties increased this capacity to some extent, or there is every reason to believe that the increase in depth would have been greater than that reported above, as for several months in the year the currents are controlled by the floods from the Sabine and Neches, rivers and are not dependent upon the tide for the head of water which produces them.

Money statement.

July 1, 1885, amount available	$107,902 46
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	105,256 10
July 1, 1886, amount available	2,646 36
Amount appropriated by act approved August 5, 1886	198,750 00
Amount available for fiscal year ending June 30, 1887	201,396 36
Amount (estimated) required for completion of existing project	2,301,250 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	1,000,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

CONDITION OF THE WORK AT SABINE PASS, TEXAS, IN AUGUST, 1885.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., September 24, 1885.

GENERAL: I forward herewith a report of Mr. T. L. Raymond, assistant engineer, on the condition of the work at Sabine Pass, Texas, at its completion late in August, and a tracing* in a separate package by mail to illustrate the report and to show the changes which have occurred in consequence of the jetties, as well as the present condition of the channel.

The results thus far obtained are even more favorable than were expected at this stage of the work. The channel between the jetties has materially improved by scour, proving beyond a doubt that the jetties when completed will do what has been claimed for them, produce and maintain a deep-water channel. On the *outside* of both jetties the water is shoaling. This adds materially to the strength of the jetties, and the oysters are growing so rapidly on both jetties that before many years both jetties are likely to have the appearance of oyster reefs.

While deeper water is being obtained between the jetties, it is not being obtained for any considerable distance beyond their outer ends. It is probable that much of the material scoured from between them is dropped just beyond, where the currents again weaken. In other words, the bar is being pushed seawards. But the advance of the bar seaward is very much slower than is the advance of the jetties, provided there is money to build them with. Our appropriation is now so nearly exhausted that work had to stop. Scouring will probably continue between the jetties and shoaling may occur beyond. If funds were available so that the work of jetty building could be continuous, the jetties would soon be beyond the crest of the bar. The deposit would continue, but would be in deeper water, where the littoral current known to exist would probably be effective in aiding its removal. In a little more than five months about $200,000 worth of effective jetty work has been done. Nearly all of this was done on one jetty (the east jetty). Eleven thousand one hundred and ninety feet, a little over 2 miles, was built in this time, thus proving that nearly $500,000 worth of work might have been done in a year on one jetty if the money had been available; and as there are two jetties to be built, work, to be the most effective and economical, should be pushed on both jetties simultaneously. Thi would involve the expenditure of $1,000,000 per year, just what ha been estimated, and would insure the completion of the work in a littl more than two years' time. The work must now cease until furthe appropriations become available. The jetties will continue to compre and settle somewhat, thus becoming less effective than if kept up t high-water level. The bar beyond will continue to grow. This wi have to be removed, and the final result is likely to be that, in conse quence of slow progress, due to inadequate appropriations, longer jetti may have to be built than were originally contemplated; and, if so, the the improvement will cost more money than the original estimate calls for. Thus far the work has cost less per cubic yard than was estimat for.

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* Tracing omitted.

Respectfully submitted.

W. H. HEUER,
Major of Enginee

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. THOMAS L. RAYMOND, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 22, 18

SIR: In view of the completion of the work under the recent contract with t "Louisiana Jetty and Lightering Company" for jetty construction at the mouth Sabine Pass, Texas, I have the honor to submit the following report upon the i provement of that harbor since March 1, 1885.

Operations under the appropriation made available July 1, 1884, were begun by t contractors on March 6, 1885, and completed August 26, 1885. During these int vening six months 77,789.6 cubic yards of brush and 11,276$\frac{1167}{2224}$ tons of stone were p into the work of building a portion of the east jetty and in adding to the height o part of the west jetty constructed in 1883.

Upon the completion of the work of construction, thirty piles were driven alo the edge of the jetties to mark their position, and a survey of the entire channel b tween the jetties for a distance of 6,000 feet beyond the end of the east jetty, a 1,500 feet behind the jetties from the shore to the outer limit of the survey.

The chart* herewith submitted exhibits in plan and profile the present conditi of the work and the changes in depths produced.

EAST JETTY.

In the annual report for 1884–'85, submitted during the progress of the wor detailed description of the line of the east jetty is given, and upon this line the je was built 11,190 feet long. Of this length all but 350 feet was originally built ab the plane of mean high tide, but subsequent settlement and compression have redu this height 1 foot to 1½ feet, leaving the first 3,000 feet at about the level of mean h tide; the next section of 3,000 feet averages one-half foot lower than this plane, wh the remainder is still fully up to the mean high-tide level.

For the first 1,300 feet from the shore the jetty averages 4 feet in height, with a wi of 15 feet. The following 1,200 feet averages 5½ feet in height, with a width of 30 in the foundation course, and of 15 feet in the top course. Thence for a lengt 1,200 feet the height averages 7 feet, while the widths of foundation and top co remain 30 feet and 15 feet, respectively. From this point for a distance of 2,300 the height of the jetty averages 8 feet and the foundation course is 40 feet wide, a top course 15 feet wide. Thence to the end of the top course, a length of 4,887 these widths are maintained, while the height averages 9 feet.

The last top mattress slopes seaward, the sea end being somewhat below the p of mean low-tide, and beyond this 300 feet of foundation-course extends, sloping depth of 4½ feet below low tide.

These elevations refer to the jetty at the time of closing the work when the mattress had been in position more than a month. The original heights, taken as

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* Chart omitted.

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section of the work was done, were from 1 foot to 1½ feet greater. The approximate uniformity of the settlement of the whole jetty, the construction of which extended over five months, seems to indicate that the greater part of this subsidence takes place during the first month after construction, though it cannot be hoped that work of this character, built principally of brush compressed by lever-power, will cease to compact itself for several years. Much of the settlement, too, is doubtless due to sinking into the bottom, but the amount of this cannot be well ascertained independently of the compression.

There have been used in the construction of the east jetty to date 66,436.4 cubic yards of brush.

Ballast.—In the use of stone, the more expensive material of the construction, the whole of the top work, which is subject to the greatest exposure to wave action, was well covered, while the foundation-mattresses were loaded with only such quantities of stone as would insure their safety from displacement during the short time which intervened before the top course was placed upon them. Thus while the proportions of stone to brush varied slightly in individual cases, the average for the whole of the foundation-course shows the proportion of 1 ton of stone to 12.1 cubic yards of brush, and for the top work 1 ton of stone to 3.8 cubic yards of brush.

Considering the jetty as a whole, the proportion stands 1 ton of stone to 7.5 cubic yards of brush.

The total amount of stone placed upon east jetty is 8,890$\frac{167}{224}$ tons.

WEST JETTY.

Owing to the settlement of that portion of the west jetty, which, in 1883, had been built to mean high-tide level for a distance of 6,146 feet from shore, it was deemed advisable to prevent the escape of water over it to about the same distance from shore as the east jetty had been carried, and the work of raising this jetty above mean high tide was begun June 26, 1885. At the close of the contract this had been accomplished for a length of 6,710 feet from the shore, and 562 feet beyond this a second tier had been placed upon the old foundation, raising this part of the jetty one-half foot above mean low tide.

This new work begins 180 feet seaward of the old shore end, owing to the advance of the shore-line that distance along the jetty.

The width of the new work for a length of 1,800 feet nearest the shore is only 10 feet, the shoalness of the water on both sides serving to render this light work secure.

The remaining 4,910 feet of the top work is 15 feet wide. At a point 2,000 feet from shore, where the depth of water over the old jetty was found to be 3 feet at mean low tide, two mattresses 20 feet wide and 2½ feet high were first sunk before laying the top course. When the end of the old top course was reached, 1,100 feet of these 20-feet mattresses were put in, carrying this work 7,272 feet from shore, and all but 562 feet of this was covered by top mattresses.

The average height of the new work is 3½ feet, except where the two tiers above mentioned were used, and there the height averages 4½ feet. The elevation of the top of the jetty, as far as completed, now averages 1½ feet above mean high tide.

The totals of material used upon the west jetty this year amount to 11,353.2 cubic yards of brush, loaded with 2,386 tons of stone, which give the proportion of 1 ton of stone to 4.7 cubic yards of brush. All the top work upon this jetty was built in place, affording a good opportunity of ascertaining the condition of the work done two years before. There seems to have been no loss, except from settlement, and measurements show that nearly all of this subsidence took place during the first six months after the construction. The growth of oysters upon the brush and stone has greatly added to its solidity and strength. The test mattress, loaded entirely with oyster shells was found to be intact, and its elevation fully up to that of the remainder of the work.

RESULTS.

The chart herewith submitted gives the results of the survey made immediately upon the completion of the contract, showing a comparison of the soundings then taken with those taken in 1881 before any work had been done, longitudinal sections of the two jetties, and a comparative profile of the bottom along the line of the deepest water.

Generally considered, there has been a deepening since 1881 of from 1 to 2½ feet over the whole area between the jetties, the greatest scour having taken place in the deepest water. The improvement in depth has extended for a distance of 2,000 feet beyond the end of the east jetty, though to a less degree than within. Beyond this there is a small area where no change has occurred, while beyond this again there has been a shoaling of four-tenths of a foot in the line of the channel and out to a depth of 12 feet been a shoaling which extends out to the 12-foot depth. The decrease in depth is greatest near the jetty, and diminishes gradually toward the eastward. The bottom over this area is hard sand, and it is evident that the shoaling has been due to the banking up of the westerly sand-drift against the west jetty; for in 1884 this sand bottom was found to extend 1½ miles to the eastward of the west jetty, while now sand is only found in isolated spots farther to the eastward than 1,800 feet from the west jetty, and at certain points it completely covers the foundation and has overflowed to the west of the jetty.

Behind the east jetty there has been a shoaling, which already amounts to a maximum of 2 feet, while it averages 1½ feet.

Considering the contours of depths, the most favorable results are observed, remembering the recent effective progress of the construction during the most unfavorabl season of the year, when the rivers are low and prevailing winds opposed to the e currents.

The 6-foot curve, which in 1881 nearly closed the exit from the pass at a point 1,0 feet inside the "Clifton," has been entirely obliterated between the jetties.

The 7-foot curve inside the bar has advanced into the Gulf 4,300 feet, measured a the channel line, and the distance between 7 feet depth inside and outside the bar h been reduced from 3,000 feet in 1881 to 400 feet in 1885. The depth between the je ties is everywhere greater than 7 feet.

The 8-foot curve inside the bar has advanced toward the Gulf 3,450 feet, while t distance between 8 feet depth inside and outside has diminished from 7,800 feet i 1881 to 4,600 feet in 1885, the outside curve having receded 250 feet, the diminuti amounting to 3,200 feet.

The 9-foot curve has advanced seaward between the jetties 1,850 feet, while t outside curve has also advanced 400 feet, leaving a net gain on the distance betwe the two of 1,450 feet.

While the advance of the outside curves is unmistakable, and indicates a tenden to shoal beyond the work now completed to mean high-water mark, the amount this shoaling is as yet small compared with the scour. The effective work has not be carried beyond the original bar, and the foundation of the west jetty, extending b yond the end of the east jetty, checks the easterly as well as the westerly Gulf c rents, causing deposits on either side of it.

With the comparatively feeble currents of the summer months there has still bee gain in depth for a distance of 2,000 feet beyond the last top mattress of the east jett measured along the channel line, and the improvement is marked across the wh entrance for a distance of 1,000 feet beyond the end of the east jetty.

Respectfully submitted.

THOS. L. RAYMOND,
Assistant Engineer.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

SUBSIDENCE OF THE JETTIES AT SABINE PASS, TEXAS.

NEW YORK, *December* 19, 1885.

GENERAL: I have the honor to forward herewith two tables, showi subsidence of the jetties at Sabine Pass, Texas, furnished by Maj. W. Heuer, Corps of Engineers. In a communication to me referring to th matter, Major Heuer states:

> That the percentage of settlement on the east jetty (the newest one) is 9¾ per cen while on the old jetty (west jetty) it is 32 per cent. If we separate this latter jet into two parts, viz, submerged and that above mean low tide, we find the subsiden of the submerged part to be 36½ per cent. Now, if we treat both jetties as one (call a jetty 27,000 feet long), the mean height of which was originally 6.82 feet, and t subsidence amounted to 1.45 feet, the percentage of subsidence averages 21 per cen This takes an extreme view of it. The measurements of heights of mattresses a taken from out to out. You remember our bottom fascines are 6 inches diameter. course when the mattress is weighted with ballast this lower course of fascines mu sink into the mud before the body of the mattress gets a bearing surface; yet this bo tom fascine is counted in the total height of the mattress. If we deduct this 6 inch from the amount of subsidence, we should have only 14 per cent. of subsidence in t entire amount of jetty built. How much of this is due to compression, how much worms, and how much to actual scour beneath the mats, nobody knows. That d to worms I don't think is worth considering.
>
> Behind the west jetty the water has shoaled from 1 to 4 feet, the greatest shoali being found near the shore. From a point 1,000 feet beyond the "Clifton," and b tween the new channel and the foundation of the west jetty, laid in 1883, there h
>
> With reference to the submerged part of the west jetty (7,000 to 16,000 feet fro shore end) where the most subsidence has occurred, we find this state of thing Close to the edge of the mats, inside and outside of the jetty, we find a trench from to 5 feet deep, and of variable width. This we have not carefully measured, but judg it to be about 30 feet wide. I believe these trenches occur from the overflow of t

ea over the jetties. The consequence is, the mud or sand beneath the mats flows into he trenches and permits the mats to sink bodily. When our jetties are built up bove high-water level, we, as a rule, have less subsidence than when they are submerged, and if the subsidence were due to compression only, we ought to get more in he high jetty than in the submerged, because with a low tide we have all the weights bove water pressing directly on our mud foundations, but with a high jetty there an be no overfall, hence no scour due to that cause; yet we must keep our foundaion course submerged and well in advance of our completed jetty to prevent injuriur scour in advance.

Very respectfully, your obedient servant,

D. C. HOUSTON.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

Table showing amount of subsidence of west jetty, Sabine Pass, Texas, from date of construction, in 1883, *to date of survey, September,* 1885, *considered in sections* 1,000 *feet long.*

Distance of section from shore origin of jetty.	Time between measurements.	Average height when built.	Average height in September, 1885.	Total subsidence.	Percentage of subsidence to first height.	Original average height referred to M. L. W.	Remarks.
Feet.	*Months.*	*Feet.*	*Feet.*	*Feet.*	*Per cent.*	*Feet.*	
to 1,000	31	2.6	1.9	0.7	27	+1.4	Average subsidence of portion originally above M. L. W. =24⅓ per cent.
,000 to 2,000	30	5.8	3.7	2.1	36	+1.4	
,000 to 3,000	24	8.3	6.6	1.7	20	+0.8	
,000 to 4,000	24	8.9	7.0	1.9	21	+1.0	
,000 to 5,000	23	8.1	6.5	1.6	20	+1.0	
,000 to 6,000	22	8.1	6.3	1.8	22	+1.4	
,000 to 7,000	28	4.9	4.1	0.8	16	−1.5	Average subsidence of portion originally below M. L. W. =36⅓ per cent.
,000 to 8,000	28	5.4	3.4	2.0	37	−1.3	
,000 to 9,000	27	5.0	3.6	1.4	28	−1.7	
,000 to 10,000	27	4.4	3.1	1.3	30	−2.0	
10,000 to 11,000	27	4.5	2.6	1.9	42	−2.8	
11,000 to 12,000	26	5.3	3.1	2.2	42	−3.1	
12,000 to 13,000	25	5.9	3.7	2.2	37	−4.0	
13,000 to 14,000	25	6.0	3.5	2.5	42	−5.5	
14,000 to 15,000	24	6.2	3.2	3.0	48	−5.8	
15,000 to 16,000	22	6.4	3.7	2.7	42	−6.0	
to 16,000	26	6.0	4.9	1.9	−32	....	

The first 7,000 feet of this jetty has this year been raised to an average height of 1½ eet above its original height, but this addition has been neglected in the above.

Table showing amount of subsidence of east jetty, Sabine Pass, Texas, from date of construction, in 1885, *to date of survey, September,* 1885, *considered in sections* 1,000 *feet long.*

Distance of section from shore origin of jetty.	Time between measurements.	Average height when built.	Average height in September, 1883.	Total subsidence.	Percentage of subsidence to first height.	Original average height referred to M. L. W.
Feet.	*Months.*	*Feet.*	*Feet.*	*Feet.*	*Per cent.*	*Feet.*
to 1,000	6	4.2	3.7	0.5	12	+2.3
,000 to 2,000	4	5.5	5.0	0.5	9	+2.0
,000 to 3,000	4	6.8	6.0	0.8	12	+2.0
,000 to 4,000	4	7.8	7.0	0.8	10	+1.5
,000 to 5,000	3	8.7	7.9	0.8	9	+1.7
,000 to 6,000	3	8.4	7.7	0.7	8	+1.8
,000 to 7,000	3	9.2	8.3	0.9	10	+2.2
.000 to 8,000	3	9.4	8.4	1.0	11	+2.0
,000 to 9,000	2	9.9	8.9	1.2	12	+2.4
.000 to 10,000	2	9.0	8.6	0.4	4	+1.8
0,000 to 11,000	1	9.7	8.9	0.8	9	+2.3
to 11,000	3	8.1	7.3	0.8	9½	....

SURVEY AT SABINE PASS, TEXAS, BETWEEN THE JETTIES AND TH TWELVE-FOOT CURVES LYING WITHIN AND OUTSIDE THE BAR.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., February 4, 1886.

GENERAL: I have the honor to forward a report and a tracing* of survey made by Assistant Engineer Thomas L. Raymond, of that portion of Sabine Pass, Texas, between the jetties and the 12-foot curve lying within and outside the bar at this locality. The survey was mad during the last days of January, 1886. The result shows that the jetties in their very incomplete condition are producing beneficial effec in making deeper water. When the jetties were commenced we had feet of water on the bar. The jetties were extended to a short distan beyond the inner crest of the bar until work terminated on account exhaustion of the appropriation last September. Since that tim barely five months, the bar has been scoured until a depth of 8 feet water is now found at *low water*, and this channel is practically 400 fe wide. The 9-foot curve inside is pushing seaward, has advanced 2,6 feet; the 10-foot curve has advanced seaward 2,200 feet, showing a material reduction in the width of the bar. As neither the Sabine nor th Neches rivers has been high, since work stopped last September, th improvement of the channel must be attributed to the scour obtain by the concentration of the tidal current directed by the jetties, a better results may be expected as the rivers rise. The scour on the b is also taking place over a distance of 3,000 feet, measuring from t outer end of the east jetty. The outer ends of both jetties above s level have sustained some damage from the action of the sea. Th can be remedied when work is resumed.

Respectfully submitted.

W. H. HEUER,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. THOMAS L. RAYMOND, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., February 3, 1886.

SIR: I have the honor to submit the following report upon the survey of the e trance to Sabine Pass, Texas, made January 25 to 27, 1886, in obedience to your i structions:

A chart† of the survey is herewith submitted comparing the positions of the c tours of the survey of December, 1881, before the jetties were begun, with those equal depths determined by this survey. A comparative profile of the line of deep water is also given to further illustrate the results obtained. The data from the ch of 1881 are shown in red.

It will be noticed that there now exists an 8-foot channel across the bar, wit least width of practically 400 feet, 7.8 feet being the shoalest intervening soundin while in 1881 barely 6 feet depth could be carried across the bar.

The 6-foot and 7-foot contours have been obliterated within the limits of the s vey, which extends from 12 feet depth inside to the same depth outside, and from t west jetty to and beyond the east jetty line.

Comparing the 8-foot contours of 1881 and 1886, it will be seen that while it do not now close across the bar, in 1881 the distance between 8 feet depth inside and o side the bar was 7,200 feet.

The 9-foot contour inside has moved seaward 2,600 feet, while the outside conto of the same depth has advanced into the Gulf, near the line of deepest water, 300 fe showing a net decrease of 2,300 feet in the distance between 9 feet depths inside a outside.

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* Tracing omitted.

† Chart omitted.

The 10-foot contour inside has moved down-stream 2,200 feet and the outside advanced 300 feet, a net decrease of 1,900 feet between inside and outside 10 feet depths.

There has been a considerable advance into the Gulf of the 8 and 9 foot contours to the westward of the channel, due to the formation of a bank against the foundation of the west jetty, built in 1883, but since the construction of the east jetty the area and height of this bank have been materially diminished.

To sum up the foregoing, the practicable depth across the bar has been increased fully 2 feet, or one-third of the original depth, by the incomplete works thus far constructed, while as far as the work has been carried the increase in depth upon the former crest of the bar has been from 2¼ to 3 feet, or about one-half of the original depth. Also a scour has been produced 3,000 feet beyond the end of the east jetty, with no alarming tendency to shoal beyond this having been developed.

An examination of the condition of the work, which was originally built to mean high tide, shows that about 700 feet of the east jetty and 5,500 feet of the west jetty remain uninjured, while beyond this on both jetties the top work is considerably damaged. In all about 4,000 feet of the top of the east jetty and 1,500 feet of the top of the west jetty have been injured.

Very respectfully,

THOMAS L. RAYMOND,
Assistant Engineer.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

R 14.

IMPROVEMENT OF SABINE RIVER, LOUISIANA AND TEXAS.

A survey of the mouth of this river was made in 1871; it had a channel over the bar 3½ feet deep. In 1872–'73 the survey was extended from the mouth to Belgora, Tex. The information obtained did not warrant the expenditure of any money for improvement above Hamilton, Tex., about 247 miles above the mouth, to which point there is 3 feet depth for about three months in each year. The estimated cost of improvement over this stretch of river by removal of obstructions, such as logs, snags, fallen trees, &c., was $18,000. In June, 1878, Congress appropriated $10,000 for the improvement, with which a channel 6 feet deep, 70 to 100 feet wide, was dredged over the bar at the mouth. March 3, 1879, Congress appropriated $6,000 more, and provided for a resurvey of the river from its mouth to East Hamilton. After this survey was completed it was deemed advisable to expend this money in improving the river above Orange, and cuts were made from the main river into the narrows and at Dead Bend; large numbers of sunken logs and snags were removed from the upper part of the narrows, enabling vessel of 5 feet draught to get 30 miles up-river above Orange.

In 1880 Congress appropriated $5,000, and in 1881 $7,000 more, for this river. The bar at the mouth had again shoaled. This was redredged in 1881–'82 to a depth of 6 feet, and a channel 100 feet wide was made, a little over a mile in length.

In 1882 Congress appropriated $4,000 more for this improvement. As the river is in a sufficiently good navigable condition for the limited commerce which it carries, this money has not been used, and it, together with a small balance left over from former appropriations, is yet available. No work has been done during the past year.

CONDITION OF THE WORK AT PRESENT.

The dredged channel has shoaled somewhat, and many saw-logs have been lodged in it, but there is a deep enough channel for the very limited commerce using the river, and while the commerce is so small and not perceptibly increasing it is deemed inadvisable to make any further improvement at present.

It is not evident that the improvements thus far made have been much, if any, commercial advantage. When the channel was at its bes freight rates were not reduced, nor did the commerce on the river perceptibly increase.

No appropriation for the fiscal year ending June 30, 1888, is asked.

Money statement.

July 1, 1885, amount available	$4,546
July 1, 1886, amount available	4,546

R 15.

IMPROVEMENT OF NECHES RIVER, TEXAS.

The Neches River was surveyed in 1872–'73 from its mouth to Boo ville, 195½ miles, and was found to be navigable at all stages to Wei Bluff, 51 miles from its mouth and above that point only during hig water, a large amount of lumber being shipped annually to Sabine Pa and Galveston. The principal obstruction to navigation was the b at the river's mouth, the depth of water on which was 3 feet at low tid the bar is of fine sand and mud, the deposit of the river.

An estimate for dredging a channel to 5 feet depth, involving the r moval of 47,851 cubic yards of material, was submitted, amounting $26,318.

The act of June 18, 1878, appropriated the sum of $8,000 for deepe ing the channel at the mouth of the river and removing obstructions Beaumont.

Advertisements under this act for dredging on the bar failed of r sult, and after the passage of the act of March 3, 1879, appropriati an additional $5,000 to the work, readvertisements were made and und the resulting contracts a channel was excavated to the depth of 5 fe and more at mean low tide, and to an average width of 60 feet, excep for 1,200 linear feet. An additional appropriation of $5,000 was mad by the act of June 14, 1880. It was contemplated to use the funds th made available in removing snags and overhanging trees between Bev port and Yellow Bluff, but as the estimate for this work resulting fro the resurvey of 1880 amounted to $15,000, operations were suspende until after the act of March 3, 1881, appropriated the sum of $3,00 when $7,465.50 were expended removing these obstructions, the riv being thus made navigable during high water, say three months in th year, to Bevilport, and during low water to Weiss Bluff. The act March 3, 1881, also provided for an examination or survey to ascertai the practicability of a deep-water channel from Sabine Pass to Oran and Beaumont, and the estimates made in accordance with the pr visions was as follows:

For a 6-foot channel	$21,0
For a 7-foot channel	42,0
For an 8-foot channel	149,0
For a 10-foot channel	377,8
For a 16-foot channel	1,350,0

It was noted in a report that the depth then existing (5 feet) was more than sufficient for all the requirements of commerce for many years to come.

By act of August 2, 1882, the sum of $5,000 was appropriated for continuing the improvement of the river, and in the annual report (1883) recommendation was made in the following terms:

> This amount is insufficient to produce a good channel at its mouth, and as this is the only place on the river really requiring improvement, it is thought best to hold this money until a further appropriation is made, then to cut a good channel say 100 feet in width and having 5 feet depth of water in it.

In the same report it was stated that:

> The channel across the bar had again shoaled until only 3½ feet of water could be carried over it, the bar being about 2 miles in length and requiring redredging about once in three years, for which, to obtain the channel mentioned above, the removal of about 40,000 cubic yards of material would be required, costing at 30 cents per cubic yard about $12,000.

No work has been done during the last fiscal year, and the recommendation that none be attempted with the balance on hand is renewed.

CONDITION OF THE IMPROVEMENT.

The depth of water in the cut across the bar seems to be generally about 1 foot less than that in Sabine Lake in the vicinity of the outer approach, quite enough for present needs.

There is no commerce upon this stream below Beaumont, with the exception of irregular trips of a small steamer to and from Sabine Pass, and as its draught is but 2 feet, the natural condition of the Neches Bar gives all the water needed for it.

For several miles below the town of Beaumont the forest growth along the banks is so high as to exclude the wind from sailing vessels to such an extent as to prohibit their use in the lumber trade without the assistance of tow-boats in this portion of their route, and, there being no tow-boat, no shipment is attempted.

Any improvement of the bar must then be supplemented by tow-boat service to be of any use whatever. Tow-boat service cannot be established and maintained unless the navigation over the bar shall be certain at all times. As any excavation through the bar will inevitably be filled up by deposits from the successive periods of high water, no relief other than the most transitory and unsatisfactory can result from dredging, unless indeed provision be made for keeping the bar dredged to the full depth required at all times and without fail. This course is, however, not recommended.

During the fiscal year 1884–'85 a resurvey of the bar at the mouth of the river was made. This channel has shoaled to 3½ feet of depth, and to deepen this channel to 5 feet would require the removal of 56,590 cubic yards of material at an estimated cost of $16,977.

The river is not susceptible of permanent improvement. With the money available from former appropriations, we can, when it becomes necessary, deepen the channel over the bar. Until this balance is used up, no further appropriations are recommended.

Money statement.

July 1, 1885, amount available	$11,667 84
July 1, 1885, amount available	11,667 84
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	11,667 84

R 16.

REMOVAL OF SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDAN-GERING NAVIGATION.

REMOVAL OF WRECKS IN HARBOR OF NEW ORLEANS, LOUISIANA.

In reply to an advertisement inviting proposals for the removal o these wrecks, opened July 14, 1884, three bids were received, which wer rejected, being considered too high, and the work advertised under different specifications.

Proposals under the new specifications were invited and opened A gust 30, 1884. These bids were again rejected, the conditions in specifications being considered illegal, and authority given to invite new proposals by circular letters addressed to previous bidders. In reply t these circulars bids were again opened on October 18, 1884, the lowes bid received being that of the Atlantic and Gulf Wrecking Compan of Somers Point, N. J., their bid being:

For removal of steamship Gresham	$16,0
For removal of ship Ailsa	5,5
For removal of steamship General Grant	6,0

This bid was approved and contract entered into November 13, 188 and approved by the Acting Chief of Engineers December 26, 1884.

Work was commenced upon the removal of steamship General Gra during the latter part of November, 1884, and continued until Januar 1885, when, on account of high water, work was suspended. Work wa resumed in August, 1885, and completed in December, 1885, all th wrecks having been satisfactorily removed.

Amount expended during fiscal year ending June 30, 1886	$28,1

APPENDIX S.

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATE OF TEXAS.

REPORT OF MAJOR S. M. MANSFIELD, CORPS OF ENGINEERS, BVT. LIEUT. COL., U. S. A., OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Entrance to Galveston Harbor, Texas.
2. Ship-channel in Galveston Bay, Texas.
3. Trinity River, Texas.
4. Buffalo Bayou, Texas.
5. Channel over the bar at the mouth of Brazos River, Texas.
6. Pass Cavallo Inlet, to Matagorda Bay, Texas.
7. Aransas Pass and Bay, up to Rockport and Corpus Christi, Texas.
8. Harbor at Brazos Santiago, Texas.
9. Protection of river-bank at Fort Brown, Texas.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 26, 1886.

GENERAL: I have the honor to forward herewith my annual reports relating to the river and harbor improvements under my charge for the year ending June 30, 1886.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Major of Engineers,
Bvt. Lieut. Col., U. S. A.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

S 1.

IMPROVEMENT OF ENTRANCE TO GALVESTON HARBOR, TEXAS.

Estimate of the Board of Engineers, January 21, 1886, House Ex. Doc. No. 85, Forty-ninth Congress, first session:

South and north jetties to crest of bar	$3,000,000
South and north jetties to 30-foot curve	7,000,000

ORIGINAL CONDITION OF THE LOCALITY.

The entrance forms connection between the Gulf of Mexico and Galveston Bay, and afforded a depth for navigation and commerce of about 12 feet over the outer bar and about 11 feet over the inner bar, with an intricate channel of 12½ feet, difficult of navigation. The outer bar, i semi-circular form, stretched from Bolivar Peninsula on the east t Galveston Island on the west, measuring 10 miles along its crest, and as shown by Coast Survey Chart No. 105, had, in 1867, but 11 feet a mean low tide in the best channel.

The inner bar, opposite the head of Galveston Island, was a shoal obstructing Galveston Channel, and, according to Chart No. 105, abov mentioned, had a mean low depth over it of but 9½ feet.

The material composing the bars, as well as the upper stratum of th shoals, beaches, &c., has all the characteristics of a quicksand, being a fine, rounded sand, comminuted shell, and sand and shells mixed. Th entrance being greatly exposed to the action of storms, waves and tid currents, made frequent changes in the shape of the bars and the cha nels across them, the progressive movement of the inlet and chann toward the southwest tending to injure the harbor, and eventually t destroy it if permitted to continue.

PROJECT FOR IMPROVEMENT.

[Recommended by Board of Engineers.]

1. To build up and complete present south jetty to the crest of th bar.
2. To build a north jetty and complete it to the crest of the bar.
3. To extend both jetties to the 30-foot contour in the Gulf.
4. To do such dredging from time to time, to aid the tidal-scour, the rate the appropriations given may afford.

For reference, and to complete the record, the report of the Board published herewith. (See paper marked A.)

OPERATIONS PRIOR TO JUNE 30, 1885.

The first appropriation was given in 1870, and from that year up June 30, 1885, $1,576,337.12 (including $100,000 of funds of the city Galveston) was the total sum expended under direction of the Unit States upon works of improvement at this point. The result of the e penditure of this money may be shown in the following manner:

The Coast Survey chart of 1867 indicated that the best water in t channel across the inner bar was then but 9½ feet at mean low tid affording for navigation passing to or from the city a depth of not e ceeding 11 feet at ordinary high stages. At the present time (June 3 1886) the available water-way for vessels is not less than 20 feet de at mean low tide, and this depth—in a good wide channel—is that o tained over a shoal at the head of Galveston Channel, which is caus by the passage of sand through the dilapidated Fort Point pile-wo opposite, built many years ago by the city of Galveston. The depth inner bar at time of last survey, June, 1884, was 26 feet, which dept is supposed to have been held up to the present.

The outer bar (as shown by same Coast Survey chart of 1867) had mean low-water depth of 11 feet and an ordinary high-water depth f crossing of about 12½ feet. In 1884 (survey of June) it was found th the mean low-water depth of bar-channel was 13 feet—the same as give the previous year—and afforded for navigation at high tide a draug not exceeding 15 feet. This satisfactory condition has prevailed to t present time, as inquiry of the pilots fails to show any detriment changes affecting either of the bar-channels.

In the last Annual Report it was mentioned that no construction work could be attempted in the year 1885–'86, because of want of sufficient funds; $1,662.88 was the amount available, and was exhausted (save $96.98 retained to meet non-payments on rolls) in making the examinations, &c., of south jetty required by the Board of Engineers.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1887.

Whatever funds may be appropriated for continuing work at this point will be expended to the best advantage, and in the manner outlined by the Board of Engineers in its report of January 21, 1886.

The estimated amount required to carry completed jetties to the crest of the bar, with a view to obtaining a depth of 16 to 20 feet for navigation, is $3,000,000; to extend the jetties to the 30-foot curve, to obtain a 25 or 30-foot channel, $7,000,000. The estimate is made contingent upon free supplies of money.

The work is located in the collection district of Galveston. The nearest light-houses are at Bolivar Point and Fort Point, at entrance to Galveston Bay.

Money statement.

July 1, 1885, amount available		$1,662 88
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,565 90	
July 1, 1886, outstanding liabilities	84 78	
		1,650 68
July 1, 1886, amount available		12 20
Amount appropriated by act approved August 5, 1886		300,000 00
Amount available for fiscal year ending June 30, 1887		300,012 20
Amount that can be profitably expended in fiscal year ending June 30, 1888		1,000,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, GALVESTON, TEX.,
Collector's Office, July 1, 1886.

Statement of tonnage at the port of Galveston, Tex., for the fiscal year ending June 30, 1886:

Description.	Number.	Tonnage.
Foreign vessels entered	164	115,487
Foreign vessels cleared	....	....
American vessels entered foreign	16	8,706
American vessels cleared foreign	21	18,634
Coasting trade entered	317	319,005
Coasting trade cleared	295	309,490
Totals	977	882,311

CHAS. C. SWEENY,
Collector.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 20, 1886.

SIR: In presenting the report of the Board of Engineers upon the improvement of the entrance to the harbor of Galveston, Tex., it migh be well to preface what is necessary to be said with a brief history o the operations conducted at that place.

The late Maj. C. W. Howell, Corps of Engineers, had presented a pr ect for the improvement of the entrance to the harbor and of the ha bor itself, which was referred to a Board of officers, Lieut. Cols. Z. B Tower, Horatio G. Wright, and John Newton, for report.

The project was the construction of two parallel jetties about 10,50 feet apart, and for the greater portion of their length submerged mean low tide. The peculiarity of the project consisted in the propose material of which the jetties were to be built, viz, hollow cylinders concrete, called by the originator gabions, deposited upright, and fill when in place with sand.

The Board, in its report of January, 1874, says:

> The Board is, therefore, of the opinion that, if piers proposed by Captain How were constructed, extending over the bar, the depth of water thereon would be i creased in an important degree, though exactly what depth might be looked for ca not be predicted. It is also believed that the inshore extremity of the pier on the Fo Point side of the entrance, from the point where it connects with the bulkhead co structed by the city to where it joins the long straight portion running to the ba will have the effect of moving the bar at the Galveston Harbor entrance near t Bolivar Channel, whereby it will, to some extent, be carried off by the main curre of the latter. * * * * The two piers will therefore have the effect, in the opini of the Board, not only of improving the outer bar, but also, incidentally, the inn bar, at the entrance of Galveston Harbor.
>
> * * * * * * *
>
> As regards the method of construction proposed by Captain Howell the Board i compelled to speak with less confidence. The importance of some device for piers o training-walls for the improvement of our harbors which shall be less costly than th hitherto practiced is readily recognized. Piers of the length and other dimensio suited to the case in question, if built of stone, resting upon the easily moved sa over which they pass, would involve an outlay which the importance of the p would perhaps not justify, and which would not probably be provided for by Co gress.

In view of the cheapness promised by Captain Howell's mode of co struction, the Board recommended experimental trials of the gabions a three places of unequal exposures, so as to test the qualities of the in vention, viz: on the outer bar, at the shore end of the proposed nort jetty, and on the inner bar; all of the tests to be made upon a sma scale.

In the same report it is stated:

> As regards the height to which the piers or training-walls should be carried in ord to obtain the desired depth, the Board does not feel able to express an opinion. (Re port of Chief of Engineers, 1874, pages 736–738.)

In the subsequent reports from this special Board, in 1875, 1876, an 1880, the same views are expressed, and it was likewise strongly rec ommended that the system of the gabionnade should not be adopte until satisfactorily tested and found to answer the purpose.

For the moderate depths then demanded the Board thought it likel that jetties at and below the height of low water would suffice. It wa desirable, also, to keep the level as low as possible on account of th greater supposed exposure to the action of waves from an elevation t the surface of the water, and in the last report of the Board it will b found that the jetties were recommended, especially their outer portions, in their first construction, to be kept low, with the intention, from the experience gained, to apply a suitable top-dressing sufficiently strong to be reasonably permanent. The actual ultimate height of the jetties would necessarily be a result of experience and of the depth to be acquired over the bar.

The parallelism of the jetties, as found in the original project of Major Howell, was, however, modified, by inclining the south jetty towards the other, and by the recommendation of the Board that, after carrying out the two jetties a certain distance, about half their proposed length, observations should be made with the view of changing their directions; that is, bringing them nearer together.

The difference between low jetties and high jetties is one of degree, not of kind, though it has been industriously promulgated that their effects are diametrically opposite. The contraction produced by the one is greater than that of the other, but is greatly more costly both from bulk of the jetties and their exposure to destructive agencies, so that if the moderate contraction proposed by the other should be sufficient it would be more advantageous to accept it.

The special Board of 1880, called together after an interval of several years to discuss the situation at Galveston, where, contrary to its advice and recommendation, a gabionnade of 9,707 feet had been constructed on the line of the proposed north jetty, sent one of its members to inspect the work, and in the report of June 7, 1880, states:

> It has failed, however, as applied to the Bolivar jetty, to gather sand-drift and to constitute a pier. In fact, the gabionnade has essentially gone down below the original bottom.

Consequently it could not serve to direct or confine the currents. It will be noted that the date of this report is prior to the commencement of the south jetty by Colonel Mansfield, and this fact constitutes a sufficient answer to the reckless and false statement said to have been uttered upon the floor of Congress, that the north jetty was in condition to act when the south jetty had been finished, and that the want of success in deepening the bar proved that the plan of the engineers had been a total failure; whereas there was but one jetty, the south, the portion of the north jetty constructed having been years before the speech swallowed up in the sand. The same report of June 7, 1880, discusses various forms of jetty as to material of construction for the information, though not as confining the efforts, of the constructing officer. Alluding to the employment of mattresses the report says:

> As small stones upon structures exposed to the action of breakers will be more or less displaced during storms, we must anticipate some damage to result from the application of either of the above methods to the construction of the Galveston jetties. Either of them, however, will probably prove a success, provided the brush collects sand and the stones become bound together by molluscous concretions, which usually grow rapidly in warm climates. Experience in Charleston Harbor and on the shores of Holland, especially at the mouth of the Maas, bears testimony to the rapid growth of these mollusca upon loose stones immersed in the sea near the outlets of fresh-water tributaries, and to their effective use in cementing them, as it were, in one mass. Though we anticipate with no degree of certainty the same favorable results at Galveston as at Charleston, yet it seems probable that similar shell deposits will occur, and that the brush and stone will collect sand in process of time. *Unaided by such favorable action*, the solidification of the jetties will be *difficult and costly*. [The italics are my own.]

It will thus be seen that the Board gave a timely warning. The south jetty, as far as the funds allowed, had been finished prior to my taking charge of the office of the Chief of Engineers, and had been brought to the level generally of low water, in some places higher and in others lower than that level. No appropriation has been made for this place since 1882, and the mass of brush in the mattresses loaded with comparatively small stones has been left during this long period exposed to the attack of the teredo and to the wash of the breakers, when it should have been promptly loaded and covered with stone large enough to resist displacement. If serious damage has resulted, it must mainly be imputed to this omission. At the mouth of the Mississippi and at Sabine, where the bottom is mainly of mud, the condition of the water will be a protection against the rapid ravages of the teredo.

In the report of the special Board of October 31, 1880, page 1453 of the Report of the Chief of Engineers for 1882, the Board states:

> An ordinary enrockment would stand probably as well upon the sands of this shore or bar as in similar positions at the north. Breakwaters in Long Island Sound and along the coast of Massachusetts and Maine are simple enrockments. No bases, either mattresses or grillages, have been required for those constructions, and none would be needed on the Galveston Bar if stone could be delivered as cheaply there (say from $1 to $1.25 per cubic yard) as in northern sections of the country. The wearing of currents or the overfall at the foot of the jetties would merely drop down the stone at the edges thus (Fig. A). But as stone costs $4 and brush only $1 per yard, economy of construction demands the use of the latter as far as possible.

The special Board from 1874 to 1880 was called together at infrequent intervals, and only to act upon some point presented to it, and during the intervals had no oversight or advisory control over the operations. The Board never possessed executive functions.

In the spring of 1885 I directed cross-sections to be taken of the south jetty, in order accurately to know its condition, with the object of an after reference of the whole subject to the permanent Board on Fortifications and Rivers and Harbors. The members of the Board visited Galveston, and after an elaborate study of the subject have submitted their report, a copy of which is respectfully submitted.

I think it important to call attention to the careful analysis made by the Board of the problems submitted to it.

Among other results the Board reports that the 24-foot curve on the sea-face of the bar has moved seaward since 1851 100 feet per annum, and the 18-foot and 12-foot curves at a greater rate. This is not supposed to be entirely due to the works that have been constructed, since this action preceded their construction, though to a less amount.

The trenches on either side of the jetties are not of unusual occurrence in such situations. In the present case they have been attributed to the overfall of the tides, and may be due also to the racing of the waves along the jetties.

The sand movements along the bottom and shores are, in the opinion of the Board, nearly equal in a northeast and southwest direction.

The inner bar has been greatly deepened by the action of the works already constructed, and may be further deepened to meet any increase of depth on the outer bar.

The south jetty has, from exposure to the various degrading causes, lost about 61 per cent. of its original height. It will yet serve as a foundation for a stone enrockment to complete the structure and bring it above the water. If it be purposed to continue the improvement, one million of dollars might be profitably expended during the coming year, and I strongly recommend, as the least amount to be of benefit and to preserve the foundations, that $320,000 be appropriated.

I invite particular attention to the conclusions of the Board that a great contraction of the channel by jetties would but slightly increase the velocities of the currents and extreme depth in the channel, while it would on the other hand ruin the harbor of Galveston, as well as expose the jetties to destruction.

The influence of too much contraction would be to diminished greatly the tidal prism in Galveston Bay; and the Board also states:

> If the jetties had an interval of about 10,000 feet and the Bolivar Gorge were widened to that amount, after a deep channel way was formed, the tidal prism of Galveston Bay would be about the same as at present.

In another part of this report it is stated:

> Such storms will endanger jetties 7,000 feet apart. If made narrower, the time of outflow would be prolonged in proportion, and hence the danger of undermining the jetties and of cutting channels across Galveston Island would be still greater.

But it is impossible in a brief space to do more than call attention to some of the important results of calculations made by the Board. The whole paper deserves a careful study.

In conclusion, I beg leave to now supply the omission in the earlier portion of this letter, to state that the special Board from 1874 to 1880, the period of its connection with the subject, had the problem submitted to it of gaining a moderate depth over the bar, and that the present depths of 25 to 30 feet on the bar were not then contemplated.

Respectfully submitted.

JOHN NEWTON,
Chief of Engineers.

Hon. WM. C. ENDICOTT,
Secretary of War.

REPORT OF BOARD OF ENGINEERS.

OFFICE BOARD OF ENGINEERS FOR FORTIFICATIONS
AND FOR RIVER AND HARBOR IMPROVEMENTS, &C.,
New York, January 21, 1886.

GENERAL: The Board of Engineers has to acknowledge the reference to it of the subject of the improvement of Galveston outer bar by your letter of July 25, 1885, and, after a personal inspection of the present condition of the work, submit the following report:

1. DESCRIPTION.

Galveston Bay is a shallow body of water, separated from the Gulf of Mexico by a low sand island 27 miles long and a mile or two in width, on which Galveston City is built, and by a spit 20 miles long, called Bolivar Peninsula. The bay is connected with the Gulf of Mexico by San Luis Pass, at the western end of Galveston Island, and by the Bolivar Channel, at the eastern end. The length of the bay along the shore is about 50 miles, and its most distant point is about 25 miles from the Gulf coast. Its area is about 490 square miles. If it be assumed that the part of the bay west of Deer Island is served by San Luis Pass, it leaves 450 square miles for the area depending on the Galveston entrance. San Luis Pass is the smaller entrance. The main entrance to the bay is between the east end of Galveston Island and Bolivar Peninsula, and it has a present width of about 8,200 feet. The interior of the bay, aside from the main entrance, has depths which do not exceed 11 feet at mean low water (the plane to which all depths refer) except where tidal channels have been formed. Thus on the north side of the island, in front of the city of Galveston, depths of 35 feet are found in a narrow channel. This area of 270 acres forms Galveston Harbor. In the gorge between Galveston Island and Bolivar Point the currents maintain a depth of over 24 feet (in places and at times reaching to depths of 50 feet) over an area about 4 miles long from west to east, and from 1,000 to 2,000 feet in width. It gives an anchorage area of 1,500 acres, having 18 feet depth or more. The Gulf end of the 24-foot area is about 2 miles east of the narrowest part of the gorge. Going east from this area the crest of the bar is reached at about 4 miles from the gorge, the depth of water there being a little less than 12 feet.

Prior to the construction of the existing south jetty the 12-foot contour curved entirely around the entrance to Galveston Bay. Into it protruded, from the inside, channels whose outer barred ends habitually gave 10 to 12 feet depth.* Swash channels along Bolivar Peninsula and along Galveston Island have existed; also channels, one running nearly east from the 24-foot area already referred to, and one southeast. These channels shifted with storms, but the main channel was never north of a line running east from the deep area.

From the east end of Galveston Island a jetty has been constructed to the southward of the 24-foot area. Its general direction is a little south of east, and its length 22,551 feet. In June, 1885, the depths of the top of the jetty below mean low water varied from 0 to 8 feet, the depth on the outer 10,000 feet of the jetty averaging 6 or 7 feet. Its outer end, built in 13 feet of water, on the outer slope of the bar, has there given depths somewhat greater than 12 feet, which was the habitual depth on the main channel bar before its construction.

The general direction of the Gulf shore of Galveston Island and of Bolivar Peninsula is about northeast. Immediately in front of Galveston entrance, however, for a distance of 4 miles, the 18 and 24 foot outer curves run nearly north, thus corresponding in some degree to the shape of the shore-line, since the east end of Galveston Island projects more into the Gulf than does Bolivar Point.

Galveston Island is low, and the part east of the city is especially so. Channels of considerable depth are sometimes formed here across the island in storms.

2. CHARACTER OF BAR.

Borings on the outer bar at Fort Point and at Pelican Spit indicate that to depths of 39 feet the bottom is composed of fine sand and broken shells. An examination by the Board of a sample of sand taken from a point on the prolongation of the south jetty in 22 feet of water showed that it was mainly composed of rounded silicious particles averaging about $\frac{1}{200}$ inch in diameter, very few rising to $\frac{1}{100}$ inch diameter, and smaller subangular fragments. Digested in nitric acid it lost 9 per cent. in bulk, this loss being chiefly due to the broken shells in it. Another sample, taken from 15 feet of water on the bar and 500 feet southeast of the end of the jetty, was slightly coarser, its particles averaging about $\frac{1}{150}$ inch in diameter and containing more broken shell and of larger sizes. Digested in nitric acid it lost 10 per cent. of its bulk. These samples of sand when allowed to fall through water aced final velocities of only one or two inches per second. In other ls, vertical currents of one or two inches velocity per second would such sand permanently in suspension. This gives an idea of the t ease with which the sand is moved by water.

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* In Chief of Engineers' Report, 1882, p. 1450, it is said: "During the winter months, when the northers prevail, is the time of greatest scour on the bar; and during the summer months, or during the absence of northers and the prevalence of easterly and southeasterly winds, the crest of the bar is always shoaled."

sample of the sand from a point 1,100 feet northeast from Fort Point t-house had very few particles reaching $\frac{1}{100}$ inch in diameter, the age being about $\frac{1}{150}$; but it contained unbroken valves of shells some fragments of shells an inch in length.

3. WINDS.

e following tables for the years 1880–'84, derived from the Signal ice reports, show for Galveston the average frequency of winds for rent months and for the year:

MONTHLY AVERAGE FOR FIVE YEARS 1880–'84.

Months.	N.	NE.	E.	SE.	S.	SW.	W.	NW.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
ry	21.4	12.2	11.2	14.8	18.2	6.2	1.6	6.6
ary	12.4	9	8.8	19.4	23.6	3	2.8	6
	11.8	10.6	8.2	24	24	6.3	2.8	5.4
	9	6.8	8.2	23.2	27.2	9.8	1.8	3.8
	5.8	6.6	9	32.2	28.2	5.2	2	3
	3.2	3.2	5.4	20	42.8	9	3.4	2
	1.2	4.6	2.2	17.4	39.8	20.4	4.4	2
st	5.2	5.8	9.4	26.6	27.8	9.8	5.4	2.4
nber	9.6	8.4	10.2	31.8	21.8	2.2	1.6	3
er	15.4	11	11.2	30	16.8	3.4	1.2	3
nber	18.4	16.8	17.8	13.6	14.8	2.2	1	4.6
nber	19.2	12.2	14.8	11.6	17.2	8.8	3.2	5.6

YEARLY DISTRIBUTION.

	140	130	168	314	226	89	24	58
	124	77	74	240	328	124	43	66
	125	100	68*	239	366	96	27	43
	132	127	119	265	306	87	21	25
	142	102	123	265	285	85	41	50
ears	663	536	582	1,323	1,511	431	156	237
nt	12.2	9.8	10.7	24.3	27.7	8.0	2.9	4.4

n examination of these tables shows that of the winds observed been 1880 and 1884, inclusive, 41 per cent. were from the NW., N., or , the first two directions being off-shore winds and the last being arly on-shore wind. The waves resulting from such winds should e no great effect in moving sand along the shore; per cent. of the ls were from the NE. and E.; their waves should give a southterly motion to the sand; 36 per cent. were from the south or southt; these should move the sand toward the northeast.

4. STORMS.

the case of storms the forces in action much exceed those at other s. Colonel Mansfield states that such storms occurred in 1853, 1867, , and 1877, and that there have been none since 1877. A description e great storm of September 14, 1875, may be found in the Chief of Eners' Report for 1876; and of the storm of September 16, 1877, in a manupt report of H. C. Ripley to Lieut. C. E. L. B. Davis, dated October 3, 1877, and in Chief of Engineers' Report, 1880, page 1214. The first of th began the night of September 14, 1875, with wind in the NE. On t 17th the water rose on the gauge to 6.48 feet above mean low water. T wind veered round by the S. to the NW., blowing from that quarter 60 miles per hour velocity, and driving out the water in the bay. I twenty-four hours the wind blew from the E., SE., and S. with a velo of 30 or 40 miles per hour. At one place the highest water was repo as 9.496 feet above low water. There was a difference of height feet in the water on the two sides of the island, and two channels cut across its eastern end, which was much lowered in height. A 5,000 feet wide and 0.9 foot deep was made across the bar in the pro gation of the Bolivar Channel.

The storm of 1877 began the night of September 15, with the easterly. On the 16th the wind was NE. all day. At 10.30 a. m. on 17th the water had risen to its maximum of 5.20 on the gauge. wind then increased to a velocity of from 40 to 60 miles per hour, ing to NNE. at 6.30 p. m., and to N. at 11.30 p. m., and then grad died out. At 10 a. m. on the 18th the water had fallen to —1.3 feet, of 6.5 feet in 23½ hours. Before its maximum height the water ros feet in 41 hours. The estimated mean velocity in the gorge whil water was falling 6.5 feet was 3.4 miles per hour. The northernmost of the island was swept away for 900 feet. The eastern end of the 1 curve in the gorge moved gulfward 1,300 feet. The part of the Fort gabionnade most recently constructed, covered with sand to a dep from 6 to 12 feet, was entirely exhumed, and a deep trench was vated on the east side of it. A trench was excavated to a depth of feet close along the south side of the Bolivar gabionnade, the tr sloping up to the normal depth at about 400 feet from the gabion

5. TIDES.

The Coast Survey chart of Galveston Harbor for 1867 gives fo mean rise and fall of the tide 1.1 feet. When the moon's declinati near zero there are two tides a day, the rise being 0.8 foot. Whe declination is near its maximum there is but one tide a day, and it is 1.6 feet. An examination of the tidal records at Galveston from to 1880, inclusive, shows that on an average there were one hundred eighteen times in the year when the tide either rose or fell more th feet, which would give such tides on fifty-nine days approximately; times when the rise or fall exceeded 3 feet, or on five days; and times when it exceeded 4 feet, or on one day. Tides occurring so r as five days in the year, or less, may at the time produce conside effects, but the degrading forces of waves and currents are actin steadily and constantly for such rare tides to control the channel bar depths, and the power which maintains those depths must be so in the more frequent tides, which occur in the weeks in which the has its greatest declination, or fifteen times in a solar month. It be seen hereafter that these tides give very considerable velocities i Bolivar Gorge. An examination of the Galveston record from A 21, 1879, to October 23, 1879, shows that for the average tide durin weeks of the moon's greatest declination, the mean rise and fall wa feet; the interval from low to high water 8.9 hours, and from hig low water 16 hours. But the tide fell very slowly after high wate quiring 9.2 hours to fall 0.5 foot, while it rose rapidly after low wa requiring 2.9 hours to rise 0.5 foot. The tidal currents from these t are the chief agents which maintain existing depths on the bar an the Bolivar Gorge, and it is very desirable to know approximately the velocities they produce; these velocities depend on the tidal prism.

Unfortunately data as to these special tides for points in the interior of Galveston Bay are not available, but there are data as to the average of all tides. From the Chief of Engineers' Report, 1877, Part I, page 463, the following may be derived:

Average tide at Galveston	1.10
Average tide at Halfmoon light-house, 6 miles from Fort Point	0.85
Average tide at Red Fish light-house, 14 miles from Fort Point	0.48
Average tide at Morgan's Point, 26 miles from Fort Point	0.38

These figures show that Galveston Bay is very far from being filled during a tide by the present entrance. If high and low water were simultaneous at all these points, the tidal prism for the 451 square miles of Galveston Bay which has been assumed as dependent on the Galveston entrance would be about seven thousand million cubic feet for a 1.1 feet tide at Galveston.

Of the interval of time between high water at Galveston and at Morgan's Point the Board has no information. An examination of some tidal observations at Red Fish light-house from January to March, 1877, indicates that the average delay to that point, 14 miles from Galveston, was about two hours counting from Bolivar Point. This delay makes the tidal prism less than it would otherwise be, and the seven thousand million cubic feet given above needs multiplication by a coefficient which may be taken as 0.7 or 0.8, giving about five thousand million cubic feet as the tidal prism for an average tide of 1.1 feet. This average tide, as it includes the effect of days when there are two tides a day as well as those when there is but one, is but 18 hours long; its time of rising being 7.3 hours and of falling 10.3 hours, as derived from six months' observations in 1878.

In estimating the tidal prism for the great declination tides of 1.8 feet it must be noticed that the tides are about 24 hours long, and that having risen to high water is 9.2 hours before they have fallen so much as 0.5 foot. This gives a very much longer period of nearly high water in which to fill the interior bay than in the case of the average tide, and it seems probable that the interior tides are increased in a greater ratio than those at Galveston, and sufficiently or more than sufficiently to cover the delay in time of high water at the interior stations. It will accordingly be assumed that the times of high and low water for these tides over the bay may be taken as simultaneous, provided the interior tides are increased in the same ratio as those at Galveston, that is in the ratio of $\frac{1.8}{1.1}=1.6$.

Computing for the 1.8 feet tides the tidal prism with these assumptions, it is found to be ten thousand seven hundred million cubic feet. Calling, in the absence of knowledge of its exact value, the duration of outflow 12 hours and the half tide cross-section at Bolivar Gorge[*] 160,000 square feet, there results for the mean velocity of outflow there during the ebb tide 1.55 feet per second.

It is also desirable to know the maximum value during one tide of the mean velocity at Bolivar Point. When the tidal heights give with times as abscissas a tidal curve of regular and nearly sinusoidal form, as is the case at the Narrows in New York Harbor, the velocity curve during a tide with times as abscissas has a similar form, which ma represented approximately by a triangle; whence it follows tha maximum mean velocity during a tide is about double the mean vel for the whole period of the rise or fall.

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[*] In the Bolivar Gorge section, having an extreme length of 8,195 feet, 1,360 feet of shoal water near Bolivar Point has been omitted. It reduces the cross-section by but 3 per cent. Its retention would give a value smaller than is just for the hydraulic mean radius.

At Galveston the tidal curve for 1.8 foot tide does not have a lar form; it rises rapidly from low water to high water, then falls slowly for nine hours, and then falls rapidly to low water. The which at first is more rapid than in a regular tidal curve, will greater differences of interior and exterior level than a regular c would give, and hence greater maximum velocities during the flood During the ebb tide the average rate of fall is slower than it woul for a regular tidal curve, and the maximum velocities will be less for a regular tide. Hence the form of the tidal curve indicates maximum flood velocities are somewhat greater for the great de tional tides than the maximum ebb velocities. The mean of the maxima is probably nearly what would be given by a regular tidal c that is, it may be taken as double the mean velocity (1.55 foot) dur whole rising tide at Bolivar Gorge, or as 3.1 feet per second. The little doubt that such velocities, occurring on fifteen days in each m are very effective in moving the light material of Galveston Harbo in maintaining existing depths. The absence of a good series of d observations of these velocities is to be regretted.

It is also desirable to form an approximate idea of the fall i water surface between Bolivar Point and the Gulf at the time of mum velocity, when the flow is nearly uniform. This can be do using the ordinary hydraulic formula, $V=C\sqrt{RS}$, where V is the velocity, C a constant, R the hydraulic mean radius, and S the slo

In obtaining the values of C, Bazin's formula, $C=\sqrt{\frac{1}{0.000085+\frac{0.}{}}}$

has been used, since the discharged measurements made on the l Mississippi by the Mississippi River Commission, indicate that Kut values of C are much too high for low slopes. In it R is the mean r in feet. If the values of all the quantities but S in the formula known, S can be computed.

At the times of maximum velocity the quantities of water flo through Bolivar Gorge and over the bar, as well as through sec approximately parallel to the bar, are equal, and the mean veloc through them will be inversely as the water cross section. The sec selected are, one, nearly a semicircle, whose radius is the distance the middle of Bolivar Gorge to the 30-foot curve outside of the one, the nearly semicircular section along the crest of the bar b the construction of the south jetty; and one intermediate between and the Bolivar Gorge. Computing for each of these sections the velocity across them, with their hydraulic mean radius and the val C from the preceding formulæ, we can find for each the value Then taking the mean of the values of S for consecutive sections a average value between them, and multiplying it by the distance, falls in the water surface between two sections result, which for form motion are just sufficient to overcome friction; summing, the fall needed for this purpose follows. The following table gives the sults. (The level of the Gulf is practically reached at the 30-foot cu as is seen from the value of the slope there.)

Section.	Hydraulic mean radius R.	Maximum mean velocity.	C.	S.	Distance between sections.	Fall.
	Feet.	*Feet.*			*Feet.*	*Feet.*
Bolivar Gorge	23.4	3.1	99	0.000042	....	......
Half way to outer bar	11.3	1.7	92	0.000030	10,250	0.37
Crest of outer bar	9.7	1.2	91	0.000018	5,750	0.14
At 30-foot curve	23.8	0.28	100	0.0000003	11,000	0.10
Sum					27,000	0.61

That is, when the mean velocity at Bolivar Gorge is 3.1 feet per second, the difference of level, there and in the Gulf, needed to overcome friction is, roughly, 0.61 foot. As the inflowing water is accelerated and the outflowing retarded by 3.1 feet per second, to obtain the actual falls the head due this acceleration, or 0.15 foot, should be added to the inflow fall, and be subtracted from the outflow fall, giving 0.76 foot and 0.46 foot for the total falls in the two cases.

In the great storm of 1877 the water at Galveston fell 6.5 feet in 23½ hours. If it be assumed that the mean fall over Galveston Bay was 3 feet, the mean velocity during the 23½ hours through Bolivar Gorge would have been 2.7 feet per second, or at its maximum about 5.4 feet. But since much water flowed outside the channel, these velocities would be reduced by 10 or 20 per cent. Such a velocity through jetties on this fine sand might threaten their stability. These estimates are based on the supposition that the mean fall over the whole bay was but 3 feet. No exact information as to the fall at interior points of the bay is at hand. If it was 6.5 feet, as at Galveston, double the above velocities would result, which confined between jetties, even although far apart, would severely try their stability.

6. PAST CONDITION AND CHANGES.

At the request of the Board, a comparative chart showing the surveys of 1851, 1872-'73, 1875-'76, and 1884 has been prepared. From a study of this chart some general results may be obtained.

South of Bolivar Point the 6-foot curve has moved south 800 or 1,000 feet since 1851, but a mile to the northeast there has been little change. Between Bolivar Point and Fort Point the 24-foot curves of the Bolivar Channel have moved slightly south, but have been practically stationary. At the east end of Bolivar Channel the 24-foot curve has moved east or seaward about 5,000 feet between 1851 and 1884, moving also a little to the north. At the west end of Bolivar Channel, between 1851 and 1876, the 24-foot curve moved westward about 2,000 feet.

On the Gulf slope of the main bar in the prolongation eastward of the Bolivar Channel the 24-foot curve has moved steadily seaward by about 3,500 feet between 1851 and 1884, while the 18-foot curve has moved 5,000 feet and the 12-foot curve 7,000 feet. Unfortunately late surveys do not extend to the 30-foot curve; hence no definite statement can be made as to its motion.

The 12-foot, 18-foot, and 24-foot curves, at points about 9,000 feet north of their intersection with the prolongation of the Bolivar Channel and 16,000 feet southwest from the same intersection, have retained nearly the same position since 1851. In other words, the sea face of the bar east of the Bolivar Channel has moved steadily eastward since 1851, the advance being confined to a length of about

28,000 feet, measured along the 18-foot curve. The advance is
rapid on the prolongation of the Bolivar Channel, where for
24-foot curve it is about 100 feet per year, and it is yet greater for
18-foot and 12-foot curves. It existed in less amount before the
struction of any harbor works which could affect it, and hence is mai
due to natural causes. In 1851 a long pocket, with 12 feet or more
water, ran south from the Bolivar Channel along the shore of Galves
Island, and another southeast from Bolivar Channel. These are
partially filled up, probably by the influence of the south jetty. Al
the south side of the existing south jetty for its outer 10,000 feet
trench has been dug in the bottom, with depth of from 4 to 8 feet,
depth of scour diminishing in receding from the jetty and disappea
at distances of from 200 to 500 feet. Major Mansfield attributes
trench to the overfall of ebb tides, which sometimes give strong
rents over the jetty. So wide a trench, if produced by overfall al
would indicate extreme mobility of the bottom. It may be in part
to the racing of waves along the jetty, notwithstanding its gentle
slopes. Similar trenches show themselves along works at Cette, St
münde, Ymuiden, and Rugenwaldermünde.

7. CONTROLLING FORCES.

The natural causes which give its form to the Galveston Bar are
motion of sand along the coast under the action of winds and wa
this motion being sometimes in one direction and sometimes in the oth
the stirring up of sand on the bar by wave action thus rendering
easily transportable by currents, and the currents due to the par
filling and emptying of Galveston Bay. As to so-called littoral
rents, Lieut. H. M. Adams states (Report of Chief of Engineers, 18
Part I, page 724):

> By careful and repeated observations for a littoral current outside of the outer
> we have determined, beyond a doubt, that this current depends entirely on the wi
> We have found it setting in both directions along the coast, but generally with
> wind at the time of observation.

Whether, on the whole, the sand movement is greater toward
northeast or toward the southwest is somewhat uncertain. The
as to winds already given indicate a prevailing action from the so
west. On the other hand the fact already stated that in their natu
condition the channels over thebar ran habitually in the direction of
to the south of, Bolivar Channel prolonged seems to indicate that
coming from the northeast controlled their positions, although this
be due to greater strength of winds rather than to greater frequen
But the fact that the 24-foot curves between Bolivar Point and F
Point have retained nearly the same position since 1851 seems to in
cate that the sand movements toward the southwest and toward
northeast are nearly equilibrum.

8. WORK DONE.

The works which heretofore have been constructed at Galveston ha
had in view, (1) to obtain greater depths on the inner bar, which sep
rates the deep water in front of Galveston from the deep water in B
var Channel; (2) to obtain greater depths on the outer or Gulf bar. Wor
for the first object have been carried on both by the city of Galvest
and by the United States. A survey in 1841 shows 30 feet on this in
bar, which is reported to have been reduced to 9 feet in 1867,

The chief cause of the shoaling appears to be the movement of sand from the south side of Galveston Island into the harbor. The stoppage of this movement by work at various times, and now by the south jetty, gave in 1884 depths of 21 feet on this inner bar. There is, therefore, now no need of doing more than to hold the present depths until the depth on the Gulf bar has been made equal to that on the inner bar. Then there will be no great difficulty in increasing it. Works for the second object were (1) the gabionnade built out from Bolivar Point to a length of about 10,000 feet in 1876–'80. This gabionnade has been buried in the sand or destroyed, and is abandoned. (2) A south jetty was then built, running from Fort Point in a direction a little south of east, and having a length of 22,551 feet. Its bottom width increased from 30 feet to 120 feet in going from the shore to the sea end. Its top was rounded, so that the top widths, which are greatest at the outer end, cannot be accurately stated; they may be called from 12 to 24 feet. The jetty was built of layers of brush mattress, about 18 inches thick, and layers of stone; about one-third the volume was of stone. A longitudinal and transverse section are given on sheet 3, herewith.

As this jetty has settled badly, an examination of the causes of settlement was made at the request of the Board, and the results are given in the letter of Major Mansfield to the Chief of Engineers herewith of November 17, 1885, and in the report of Mr. Picton of November 6, 1885 (Appendix B).

In general terms the results are as follows: At five places distributed along the jetty the average of original heights was 9.37 feet. The average subsidence of the top is 5.77 feet, or 61 per cent. Borings in the center of the jetty in each case showed that the base of the jetty there had not settled. The subsidence there then must be attributed to the compression of the brush-work of which the mattresses were constructed, this compression being increased in places by the very serious injury which the teredo had done to the brush itself, or possibly in some cases, although none are reported, to the destruction of the top mattress. At certain distances from the axis of the jetty, points are reached where but a single mattress should be encountered in boring. On the south side, and within 9,310 feet of the outer end, examinations showed that the single mattress had settled from 5 to 8 feet, this apparently being due to scour through the mattress of overfall currents and waves. At one boring, 581 feet from the outer end, no trace of the mattress placed there could be found. At 9,301 and at 16,801 feet from the outer end of the jetty the scour under the mattress extended nearly to the axis of the foundation, here 90 and 60 feet wide, and in the vicinity of the latter point there was a scour of from 6 to 12 feet on both sides of the jetty. In connection with this subject a report of Major Mansfield to the Chief of Engineers, of July 29, 1885, inclosing Mr. Ripley's report and sections of the south jetty, is given in Appendix A.

Major Mansfield (Chief of Engineers' Report, 1885, page 1450) gives the cost of the south jetty at $3.29 per cubic yard. A settlement of over 50 per cent., if due to compression, more than doubles this cost per cubic yard after settlement, and makes it exceed the cost of rubblestone, which may be taken as $3.50 or $4 per cubic yard. The use of stone for the bulk of the jetty is then preferable to that of brush-work, which may be seriously injured by the teredo. An examination of the cross-sections of the jetty, given on sheet No. 3, herewith, shows that for the outer 9,310 feet the highest point is now 10 or 20 feet to the north of the longitudinal axis, and from 1 to 3 feet higher than at the axis where, when first constructed, the height was greatest. This in

dicates either a movement of the stone on the top of the jetty to
northward or scour under the south side of the jetty, or a combi
of these two causes.

9. PLAN OF JETTIES.

A statement of the existing conditions at Galveston entrance has
been given. Deeper water on the bar is needed, and the question to
considered is, how that deep water can be obtained. The recogni
methods are two—(1) by dredging alone; (2) by using tidal scour
tween jetties, aided, if necessary, by dredging. The first method
already been tried unsuccessfully by Major Mansfield (Chief of E
neers' Report, 1884, Part II, page 1298). With the very mobile mat
of which the outer bar is composed and its great exposure, lying a
does about 4 miles from land, there is not, in the opinion of the Bo
sufficient prospect of results commensurate with the cost of dredg
being obtained and maintained to justify further experiment. The
ond method would include the obtaining of a deep channel-way,
tected by jetties from the deteriorating effect of wave-action and f
the influx of sand, and the maintenance of that channel-way by the
of tidal scour, supplemented, if found necessary, by dredging. The j
ties should be so placed as to secure the greatest tidal scour practic
without seriously injuring the interior harbor, and without greatly
dangering the safety of the jetties against undermining, or of Galve
Island against overflow in great storms. The greatest scouring e
will be obtained, and the greatest security against undermining,
making the jetties tight and by raising them above high water.

In fixing the interval between the jetties it must be remembered
the velocity of the water flowing through them will depend on the
of its surface and on the depths. In what follows, it will be assu
for the purpose of discussion, that jettied channels of different wid
but all having the mean depth of the Bolivar Gorge section previo
given, namely 23.4 feet (corresponding to a maximum depth of 41 f
have been formed, and it will be the falls and velocities through
channels which will be considered, since these velocities would be
natural agencies efficient in maintaining such improved channels.

How will these falls through such jetties vary, as the intervals
tween the jetties vary?

For an inflowing tide with the present entrance it has already b
seen that the fall from the 30-foot curve to the Bolivar Gorge, a dist
of 29,000 feet, is, approximately, 0.76 foot.

Suppose a channel of the same width (6,835 feet), cross-section (160,
square feet), and mean depth (23.4 feet), as the part of the Bolivar G
section we have been considering be opened to the 30-foot curve. F
the formula previously given compute for 0.9 foot fall (which, as
be seen hereafter, is the greatest possible fall for a tide of 1.8 feet),
velocity through it (first deducting from the total fall 0.10 foot for
needed for acceleration, leaving 0.8 foot to overcome friction) and th
results 2.5 feet as the maximum velocity this fall could give thro
such a jettied channel. As the actual fall would be somewhat less th
the maximum 0.9 foot the velocities would not exceed 2.4 feet.

Again, suppose a jettied channel of the same mean depth, but of twe
times the width of the Bolivar Channel, to be opened from Galves
Bay to deep water outside. Such an entrance would fill Galveston B
rapidly, and filling it so rapidly there would never be a difference
level between its inner and outer ends nearly as large as now exists

the places of those ends. Now, let this width be gradually diminished; the bay during rising tide would fill more slowly, and its surface would have greater differences of level from the open Gulf than before—that is, the maximum difference of level would increase. If the narrowing process were continued till the interval between the jetties were reduced to a few feet, water enough would not flow through them during a rising tide to seriously affect the level of Galveston Bay, and the difference of level would reach its maximum value. The level of Galveston Bay would then be constant—namely, the level of half tide; and since the tides we are considering are 1.8 feet tides, it follows that no matter how small the interval between jetties 29,000 feet long is made, the maximum value of the fall through them for a tide of 1.8 feet is one-half that tide, or 0.9 foot.

It has already be seen that if the Bolivar Gorge section were carried out to sea between parallel jetties the maximum velocities through it would not exceed 2.4 feet for the 1.8 foot tide which now gives 3.1 feet maximum velocities in the Bolivar Gorge. In other words, such a jettied channel offers more resistance to inflow than does the present entrance; reduces the present tidal prism about one-third; allows the bay to fill more slowly than the present entrance does, and hence gives greater differences of level than the 0.76 foot given by the present entrance. As the interval between parallel jetties 29,000 feet long, then, is narrowed from 6,825 feet to, say, 100 feet, the fall through them or the maximum depression of the bay below the Gulf only increases from some such quantity as 0.8 foot to 0.9 foot, and the maximum increase in velocity, therefore, would not exceed 6 per cent. While these computations are only approximations, as any such estimates must be, they show very clearly that narrowing the interval between the jetties below 7,000 feet, no matter to how great an extent, but very slightly increases the velocity through them.

Diminishing the interval between the jetties from 7,000 feet to 3,500 feet changes the differences of level between the bay and Gulf but slightly. Through the opening of the same depth and double width, about twice as much water will flow in and out, but as it flows through a double cross-section its velocity is nearly the same, and as the depths it can maintain depend on the velocities, other things being equal, the depths also will be nearly the same. There is, then, very little to be gained in the way of velocities or of depths that will be maintained by them, by narrowing the interval between the jetties to 2,000 feet, as proposed by Mr. Eads to the River and Harbor Committee, May 22, 1884, as reported in the Galveston News of June 2, 1884:

> Mr. BAYNE. Nothing like 12,000 feet?
>
> Captain EADS. That is a matter I should take into serious study before I should determine what particular width and direction I should give, but I do not take it to be over 2,000 feet.

But there is very much to be lost. A reduction of the entrance width to 2,000 feet would reduce the amount of water entering and leaving Galveston Bay during a tide of 1.8 feet to about one-fourth of its present amount. The tidal channels which are now kept open by this water would shoal up; the reduction would probably ruin Galveston Harbor proper and very largely diminish the depths at the Bolivar Gorge. Aside from the great damage it would do to all the tidal channels now existing inside of the outer bar, it would also increase the danger of injury to the jetties in great storms. In such storms, with winds from northeast to south, Galveston Bay, as already seen, may slowly fill to great heights; if, then, the wind suddenly shifts to north or northwest from south, the water is driven out with high velocities. In 1875, i this way, a deep channel was cut across the eastern end of Galvest Island, and the main bar was cut down. Such storms will endange jetties even 7,000 feet apart; if made narrower the time of outflo would be prolonged in proportion, and hence the danger of undermining the jetties and of cutting channels across Galveston Island woul be still greater. If the jetties had an interval of about 10,000 feet, an the Bolivar Gorge were widened to that amount, the tidal prism o Galveston Bay, after a deep channel-way was formed, would be abou the same as at present. But the cost of the work would be great i comparison with the resulting benefits.

These considerations lead the Board to the conclusion that when th jettied channel is fully formed its cross-section should not be less tha that of the section at Bolivar Gorge. Even with that section the maximum velocities through the jetties will be about one-fourth less than th existing maximum velocities through Bolivar Gorge for a 1.8-foot tid and the tidal prism of Galveston Bay will be reduced by about th same fraction. The present effective cross-section at Bolivar Gorge i 6,835 feet wide, with a mean depth of 23.4 feet and a maximum depth o 41 feet. The Board therefore proposes 7,000 feet for the interval betwe the outer ends of the jetties. The south jetty should be construct on the present south jetty (using the side of shoalest water) and in i prolongation. The proposed site of the north jetty is shown on Shee No. 1, herewith.

The depth which such jetties will maintain cannot be stated with pr cision. Some general considerations bearing on the subject will b given. It has been seen that a 1.8-foot tide now gives a maximu mean velocity over the outer bar of 1.2 feet. Since the bar is lower i front of the Bolivar entrance than nearer land, the velocities are prob ably somewhat greater here than their mean value, but how much is n known. With the proposed jetties the maximum mean velocity woul be increased here (the whole channel being supposed to be formed so a to give a cross-section equal to that at Bolivar Gorge) to about 2.4 fee The effect of the jetties would then be to give, where the bar now i velocities about double those existing there at present. What dep these new velocities will maintain in the jettied channel, were it by an means once fully formed, cannot be stated with exactness. Maximu velocities for the 1.8 foot tide (equal to 3.1 feet per second) now maint a mean depth at Bolivar Gorge of 23 feet, and a maximum depth of 4 feet, while the corresponding mean velocity on the bar of 1.2 feet mai tains there a mean depth of about 10 feet, and a maximum of 12 or 1 feet. Did the mean depths vary simply as the mean velocities the mea depths in Bolivar Gorge and on the bar would indicate a mean depth o about 18 feet between the jetties for 2.4 feet maximum mean velocit At the Bolivar Gorge section the maximum depth of 41 feet is 1.8 time the mean depth 23 feet. Should the same ratio exist between the je ties the maximum depth maintained in the jettied channel would b about 32 feet.

Thus far the jetties have been supposed to prevent any passage o water through them or over them. But it is not practicable to mak them absolutely tight. If of rubble stone and five miles long, with differences of water-level near their shore ends often reaching 0.6 or 0. foot, the leakage through this portion will be considerable, reducing th amount of water that would otherwise flow between the outer ends o the jetties, and perhaps causing settling. This escape in some degre diminishes the velocities near the ends of the jetties, and the depth those velocities would maintain. Unless fine material can be obtained to fill the interstices between the rubble and make the jetties compact, it may be found advisable to build for that part of the shore ends which will not soon be protected by the shore-line advance, a wall about 4 feet thick, of concrete in bags, to prevent this escape where it would be most serious. For fine material coarse gravel would be excellent.

There is, however, a point to be considered, wherein the effect of jetties is in favor of greater depths for given velocities than are maintained now. The depths tidal currents can maintain depend, not only on their velocities, but also on the strength of the causes tending to destroy or degrade their channels. At present the outer part of Bolivar Channel is exposed to the free influx of sand from the shore, under the action of lateral currents and waves; with jetties completed the wave action will be much reduced, and the currents will flow in the direction of the channel—both favorable to greater depths than equal velocities would now give.

Again, at present great and lasting effects in increasing depths cannot be attributed to the extreme tides, which only occur a few times in a year, since the degrading causes are incessantly in action. With a channel once jettied the power of the degrading causes would be weakened, and the effect of the great and rare tides would be more lasting.

On the whole, therefore, there is reason to expect that the proposed jetties, when the channel is once formed, will maintain some such depth as 25 or 30 feet. They will maintain practically all the depth that could be maintained by tidal currents between any jetties however near each other, but will not involve the dangers already specified of close jetties. In forming the channel at first dredging might be useful, or even necessary, should hard places be found. If appropriations be large it would hasten the time when the new channel would be fully developed, since the process of scouring out the jettied channels by the tidal currents would be a slow one. The advisability of dredging would depend much on the rate at which appropriations were given. Should the jetties fail to maintain the depth of 30 feet desired by Texas, they would give a protected area within which dredging to that depth would be easy, and the dredging would be reasonably permanent.

It will be seen that the Board does not attempt any prediction of the precise depth the jetties will maintain. Such predictions can best be made by those ignorant of experience in tidal entrances elsewhere and having great confidence in the credulity of mankind.

The case differs widely from that of South Pass. There, by proper works, the same amount of Mississippi flow can be forced through the jetties, whether the water-way is about 900 feeet wide, as at first constructed, or about 600 feet wide, as is now the case at the narrowest place; and the same amount flowing through a narrower water-way necessarily gives greater depths. But at Galveston before the water can flow out it must flow in, and any serious reduction of the inflow cross-section below the section now existing at Bolivar Gorge at once reduces the tidal prism of Galveston Bay and the amount of outflow in about the same proportion. The reduction of width from 900 to 600 feet in the much simpler case of the South Pass sufficiently indicates the uncertainties in such works and the small value of predictions.

The facts that the bar, including its outer 24-foot curve, has been moving steadily seaward in front of the Bolivar Gorge since 1851, and that this motion existed before the construction of any works which could have influenced it, have already been stated. The construction of jetties will tend to check this advance for some years, because the jetties near their shore-ends will form large triangular reservoirs, to receive the sand moved toward them. On the other hand, some of the sand scoured from between the jetties will be dropped beyond their outer ends, thus promoting bar advance. How far for some years these opposite tendencies will balance each other in affecting the present rate of bar advance can best be learned by experience. Since this advance existed prior to any works, it will ultimately exist after their construction.

10. CROSS-SECTION OF JETTIES.

An examination of the existing south jetty by the Board showed that the stones near its shore-end had become considerably consolidated and tightened by the growth of marine animals and the accumulation of sand. The same result is expected for additional stone-work below low water, especially at the shore-ends.

The following is in general terms the cross-section of the proposed jetties. It should be modified in details when experience acquired on this unstable bottom shows it to be necessary. In the shoal water it is very possible that it may be somewhat reduced. (From the bar to the 24-foot curve it may be necessary to protect the foundation by a layer of heavier stones, and this is included in the estimate.) Top of jetties to be 5 feet above low water, but to slope to level of ground at their inner ends. Foundations to be a brush mattress, 3 feet thick, covered at once by 4 feet of rubble, with widths increasing from 60 feet near shore to 90 feet at bar and 100 feet beyond. Jetties to be 12 feet wide on top, and of rubble-stone, with side slopes of 1 on 1 out to crest of bar—except for about 10,000 feet inside of crest, for which distance the rubble jetty is to be 22 feet wide at low-water level, and on this a concrete mass 12 feet wide is to be constructed, reaching from 5 feet above low water to 2 feet below. The rubble side slopes, from about 6 feet depth outward, to consist of heavy stone blocks, whose weight at the bar reaches 6 or 8 tons. From crest of bar to 30-foot curve jetties to be concrete piers, their widths being 18 feet at crest of bar, 24 feet at 18-foot curve and outside of it. These piers may be built either of concrete in huge bags, as the breakwaters at New Haven, England, and Aberdeen were built, or of concrete in large blocks; in either case being topped with concrete in mass. Such a concrete pier at present would be cheaper than a rubble jetty protected by heavy concrete blocks; but as it will be some years before they will be built, the question should be reconsidered in view of the prices then existing and of experience then gained. The new south jetty should follow the existing south jetty in a general way to utilize most economically existing work—selecting the shoalest side of any part of it for the new work there, but avoiding abrupt changes of direction.

The order of construction should be: First, to complete the south jetty to the crest of the bar; second, the same for the north jetty; third, carry both to the 30-foot curve.

Since carrying the south jetty out to the bar will reduce considerably the water cross-section on the bar, the velocities and depths there should be somewhat increased by that jetty alone. When both jetties are completed to the bar, there is reason to believe that they will, when their full effect is produced, give depths about two-thirds of those which jetties carried to the 30-foot curve will give.

As the jetties will diminish the freedom of inflow at Galveston they will tend slightly to enlarge the San Luis Pass. It should therefore be watched.

The estimated cost of these jetties out to the crest of the bar is $3,000,000, and this amount will probably give two-thirds of the depths that jetties carried to the 30-foot curve would give.

The estimated cost of jetties completed to the 30-foot curve is $7,000,000, their aggregate length being nearly 54,000 feet. This estimate supposes that the money is freely supplied.

Respectfully submitted.

J. C. DUANE,
Colonel, Corps of Engineers, and Bvt. Brig. Gen., U. S. A.
HENRY L. ABBOT,
Lieut. Col. of Engineers, Bvt. Brig. Gen., U. S. A.
C. B. COMSTOCK,
Lieut. Col. of Engineers, and Bvt. Brig. Gen.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

INCLOSURES.

A.—Major Mansfield's report of July 29, 1885, to the Chief of Engineers, covering a report from Mr. Ripley.

B.—Major Mansfield's report of November 17, 1885, to the Chief of Engineers, covering a report from Mr. Picton.

*Sheet No. 1.—Map of Galveston Harbor, showing proposed jetties.

*Sheet No. 2.—Comparative chart of Galveston Harbor for different dates.

*Sheet No. 3.—Sections of existing south jetty appertaining to A.

A.

REPORT OF MAJOR S. M. MANSFIELD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 29, 1885.

GENERAL: I have the honor to submit herein a report upon a recent examination made of the Galveston jetty by Assistant Engineer Ripley.

Mr. Ripley's report is so in detail and covers the subject so thoroughly that but little is left for me beyond transmitting it.

I wish to say, however, and it should be remembered, that the original profile of the jetty, and former cross-sections, with exceptions noted, were taken at the close of each day's work before any compression took place or any of the rock crest was disturbed. It was not unusual for the superintendent to report a subsidence of the work placed on previous days, sometimes as great a subsidence as 2 feet and more upon the crest, and this was not unexpected from the very nature of the construction.

Owing to the difficulty likely to attend the placing of the fourth (top course) course of mattresses, the third and fourth courses were placed together; first, the third course with just sufficient stone to sink it in place, then the fourth course, placing upon the latter the complement of stone intended for both mattresses. Much the larger proportion of this stone was laid along the crest with the expectation that the sea would distribute it upon the slopes.

With this extra weight of stone directly on the crest and the extra thickness given to the mattresses of these two courses along the axis, it is not surprising that considerable difference in height of jetty should be found to exist at the present time as compared with the origi height, and this difference is probably not greater than might be reaso ably expected. How much of the total depression is due to this ca alone it is, of course, impossible to determine.

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* Omitted.—Published in House Ex. Doc. No. 85, Forty-ninth Congress, first session.

It was customary before laying a mattress to sound and note t depth and character of the bottom, and in laying the top courses mattresses we invariably found the bottom and second courses intac and usually charged with sand, except perhaps on the immediate s face, and very little settlement thereof was noted.

If the inference is correct that these lower courses were filled wi sand and were therefore indestructible, the depression of the final wo must be accounted for either by the bodily settlement of the work the almost total destruction of the top courses. Our present exami tion does not enable us to answer the question satisfactorily. There abundant evidence furnished here that indicates clearly that bodi settlement has taken place, and it occurs in almost every secti taken, notably in sections Nos. 3, 5, 9, and 10, while a study of t other sections furnishes no proof to the contrary. How much of t depression of the crest is due to this cause is therefore indetermin

That the teredo has attacked and destroyed some of the brush th can scarcely be a doubt. It is not to be denied that this worm i sure destroyer of timber within its reach, and it is not attemp to deny that the brush which constitutes a large part of our struct has been injured where exposed to attack. Our expectation was t funds would be furnished in sufficient quantities to enable us to co the brush entirely from the attack of the teredo, and it is belie that this would readily have been accomplished. Wherever the w has been etablished above overflow the sand has heaped about i preserved it; where the work was low the currents sweeping ove probably prevents the accumulation of sand upon the surface. I possible, and even probable, that the bulk of the mattress work is c pletelyfilled with sand, and while so filled is proof against the rava of the teredo. Our examination does not show anything to the c trary. The samples of brush were grappled up *from the surface* of t jetty, and may have been merely odds and ends that stuck up thro and above the stone, which is found everywhere, a solid covering o the jetty; and as this brush has been there a period of two or th years it is not to be wondered at that it should be thoroughly ho combed. If we were to dig down into the body of the jetty, I am s isfied we would find the brush as sound as the day it was cut. It m be the currents constantly sweeping the jetty expose fresh brush attack, and that by slow progression the jetty is wearing away. such case it is merely a question of time when it will all have gone.

As the teredo does not penetrate the wood while the bark is on, d estruction is therefore slow, for only at the butts and where the b is abraded can the worm make a lodgment.

That this brush, even if largely eaten up, has served its purpose mirably, cannot be denied. It has furnished, I might say, the fiber t has served to hold the stone and sand in place and made the wor compact mass upon an insecure and uncertain foundation, while it h produced results in channel depths that are most valuable and that c not be gainsaid.

It is to be regretted that this all-important question of how much the loss in height of our jetty is due to the teredo could not be sat factorily determined. In this connection, I cite from a report of t

Government agent at the Aransas Pass work, just made to this office, under date of July 17, 1885:

> Yesterday I made a thorough examination of the jetty to see if the teredo had done any damage to the brush-work or piles. I found that they have attacked all the exposed piles, and have penetrated from 1 inch to 1¼ inches. Of course I cannot tell whether they have reached the piles which are surrounded by brush or not. I found a few instances where they have attacked the brush, *very few*.

The only evidence of the action of waves and heavy seas upon our jetty that is apparent is a possibe shifting of the crest of the jetty from its axis, and is unimportant, except as a warning against the too liberal use of small stone upon the surface of the jetty near the water-level.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. H. C. RIPLEY, ASSISTANT ENGINEER.

GALVESTON, TEX., *July* 17, 1885.

COLONEL: I have the honor to make the following report relating to the examination of the south jetty, Galveston Harbor:

The examination occupied five days, from June 17 to 22, and the weather during each day was unexceptionally fine for the purpose. The accompanying drawing exhibits the results of the examination as far as it can be shown graphically.

Eleven cross-sections were taken at nearly equal distances throughout the whole length of the jetty, averaging about 2,000 feet apart; they were taken by stretching a line across the jetty at right angles to its axis, and sounding every 5 or 10 feet for a distance of 70 to 150 feet on either side of the axis. The profile was taken by zigzagging slowly across the jetty, and noting and locating the least soundings at each crossing. In this way the height of the crest was determined at eighty-seven places, averaging about 230 feet apart. The profile constructed from these soundings is shown on the drawing, together with a profile of the original bottom, or bottom at time of placing the foundation course, and a profile of the top of the jetty at the time of placing the upper course. From these we get the following results:

	Feet.
Average depth of bottom	8.88
Average depth of top at time of placing	0.16
Average depth of top at present time	4.68
Average height as completed	8.72
Average height at present	4.20

Average subsidence, 4.52, equal to 51.8 per cent.

Taken in sections of 5,000 feet, commencing at the outer end, we find the average subsidence to be as follows:

	Per cent.
0 feet to 5,000 feet = 5.96 feet equals	51.7
5,000 feet to 10,000 feet = 5.18 feet equals	52.3
10,000 feet to 15,000 feet = 5.05 feet equals	39.9
15,000 feet to 20,000 feet = 5.46 feet equals	80.1
20,000 feet to 22,551 feet = 1.36 feet equals	20.3

Cross-sections Nos. 1, 2, 3, and 4 were taken at points where previous sections had been taken, which are plotted together with an outline of the foundation-course mattresses as placed for the purpose of comparison. At the points where cross-sections Nos. 5 to 11 were taken no previous sections had been taken, but from the records of construction there has been plotted an outline of the foundation course and of the upper course as they were placed.

Observing the cross-sections in detail, it will be seen that at No. 1, on August 8, 1882, two sections were taken, one before and one after placing the third and fourth courses. These are shown in red ink. On December 2, 1882, another cross-section was taken at the same point, which is shown in blue ink. From these it will be seen that from August 8, 1882, to December 2, 1882, there took place a subsidence of 1 foot in a period of about four months, which is at a rate of .25 of a foot per month; and from December 2, 1882, to June 17, 1885, there took place a maximum subsidence of 4.8 feet in a period of about thirty months, which is at the rate of .16 of a foot per month. It will be observed that the crest of the jetty lies to the north of its axis, indicating that the stone which was placed in larger quantities along the axis has been washed towards the north. This movement of the crest of the jetty to the north is observable in nearly every section, especially the outer ones. It will also be noticed that the appearance of rock 7 feet on the north side and 10 feet on the south side beyond the foundation course indicates that some and perhaps considerable stone may have been washed entirely off of the jetty. At No. 2 two sections were taken October 21, 1882, one before and one after placing the third and fourth courses. The subsidence at this point from October 21, 1882, to June 18, 1885, a period of about thirty-two months, is 7½ feet at the axis, which is at the rate of .23 of a foot per month; No. 3 shows a subsidence of 7.7 feet; No. 4, 9.2 feet; No. 5, 6.7 feet; No. 6, 3 feet; No. 7, 4 feet; No. 8, 3.8 feet; No. 9, 8.2 feet; No. 10, 4.5 feet, and No. 11, 1 feet. At No. 11 it will be seen that the sand entirely envelopes the brush-work, and it is probable that the loss in height at that point is due alone to the leveling down of the stone along the axis. Samples of brush and stone were grappled up from the surface of the jetty at sections Nos. 3, 4, 5, 6, 7, 8, 9, and 10. The stone was covered with barnacles, moss, and some coral, but no oysters. The brush was similarly covered, and with the addition of a very few small oysters on one sample (at No. 5). Sample at No. 3 was thoroughly honeycombed and abandoned. It was placed December 23, 1882, and had therefore been in the jetty about 2¼ years. Sample at No. 4 was placed November 28, 1882, and was thoroughly honeycombed and abandoned. Sample No. 6, placed January 10, 1883, was completely honeycombed and abandoned. Sample No. 7, placed June 14, 1883, is a piece of oak with the bark still on; although pretty thoroughly honeycombed, it still possessed considerable strength and the worms had evidently not finished with their work. Sample No. 8, placed September 17, 1882, was thoroughly honeycombed and abandoned. Sample No. 9, placed June 18, 1883, was thoroughly honeycombed and abandoned. Sample No. 10 contains a piece of brush only slightly eaten by the worms. Although exposed to their action, as is shown by its want of bark and accumulation of barnacles, yet they seem to have abandoned it after penetrating only a short distance. The other pieces of this sample were thoroughly honeycombed.

The question naturally arises, What has been the nature of the subsidence of the jetty? It must be admitted, I think, that this examination does not furnish a completely satisfactory answer. Section No. 5 shows an undoubted settlement of the whole body of the jetty from the south side, to within 2 feet of the axis, or for a distance of 43 feet from the edge. At this point the top of the jetty is just even with the bottom at time of placing the foundation, and, in order that this should result, some settlement must have extended still further and probably passed beyond the axis of the jetty. Allowing for a similar settlement on the north side, the whole subsidence may be accounted for alone by bodily settlement. At this point the jetty has a base of 90 feet. Section No. 3 shows an undoubted settlement of the whole body of the jetty from the south side to within 13 feet of the axis, or for a distance of 47 feet from the edge; in this case the south edge is 60 feet from the axis. It seems probable, therefore, that some settlement has extended beyond the axis, and hence we might reasonably conclude that at this point the entire subsidence is due to settlement bodily. The same remarks are also applicable to sections Nos. 9 and 10. But when we come to consider sections No. 1 or 2, it is not apparently probable that the jetty has settled bodily, and yet there is no proof to the contrary. On the other hand that the worms have eaten off the brush composing the mattresses is certain, and that a compression is due to this cause is also certain. We also have evidence of the rock having been washed off of the jetty, and we cannot assert positively that the subsidence at Nos. 1 and 2 may not have resulted from the two causes combined without any bodily settlement. Hence it may be said that the results of this examination do not completely answer the question involved, for it does not enable us to determine how much of the subsidence is due to the action of the sea and worms and how much to bodily settlement.

Very respectfully, your obedient servant,

H. C. RIPLEY,
Assistant Engineer.

Bvt. Lieut. Col. S. M. MANSFIELD,
Corps of Engineers, U. S. A.

B.

REPORT OF MAJOR S. M. MANSFIELD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., November 17, 1885.

GENERAL: Referring to the letter of the Board of Engineers of Auust 7, 1885, referred to me by indorsement, recommending that borings e made at numerous places along south jetty at Galveston, Tex., to dermine, if possible, to what is due the apparent settlement of the jetty, have the honor to say that borings have been made to the extent of vailable funds, and the detailed report of Assistant Engineer Mr. J. [. Picton, who conducted the operations, is respectfully submitted hereith, and the letter of the Board is returned to your office.

Six borings were made on or near the axis of the jetty; two of them, os. 1 and 8, were near the outer end of the work, the portion longest place and most exposed to the action of the sea. The boring nearst the shore was 3,084 feet from the inner end of the work, and the reaining borings were at intermediate points, and for ready reference e located upon a lithographic chart herewith.

The opinion I have arrived at from a study of the cross-sections at the tty made in June last by Mr. Ripley, that there was abundant evidence a bodily settlement of the work, has been completely disproved by is examination, which shows that no bodily settlement of the jetty as occurred along or near its axis. The edges of the jetty have gone own with the washing out of the underlying sands, precisely as had een anticipated, and in these respects our original views upon the adopon of this system of brush mattress work for the construction of the alveston jetty are fully confirmed.

It was originally thought that the brush, if used as a hearting to the ork, would compress about 33 per cent., but our examination shows the points of boring a loss in height of jetty of 61 per cent. It will observed in boring No. 8 that the thickness of the foundation brush found to be (12 feet—10.9 feet) 1.1 foot, the average thickness of the ush when placed being 1.5 foot, and the brush being found in sound ndition, the loss is doubtless due to compression alone, and is about per cent. This may be exceptional, and is so in reference to this exaination, and therefore little value should be placed upon this circumance. Indeed we find at boring No. 2 a thickness of foundation brush only (5.9 feet—5.1 feet) 0.8 of a foot, which, compared with the origal thickness, (1.5 feet, average), is a loss of 50 per cent. Here the undation course of brush was exposed to the ravages of the worm om May 24, 1882, to February 20, 1883, before the second course of ush was placed thereon—a period of nine months.

At borings Nos. 1, 8, and 9 the upper work had been disturbed and oken by heavy seas soon after being put in place, and was repaired on after by a deposit of riprap stone along the crest, and the results the examination at these points, so far as making a characteristic owing of the whole jetty, may be somewhat affected in consequence.

It is well shown, I think, that where the brush is covered it has been eserved safe from the attacks of the teredo, and where samples of ush from the lower work shows signs of having been attacked and en abandoned, it is clear the teredo has been destroyed therein by ing covered by upper work and the accumulation of sand and shells.

The jetty seems to be a very compact mass of brush, stone, shells, and sand, and is well covered upon its surface with stone having coral growing profusely, mingled with the oyster and other molluscous formations.

It has been impossible from this examination to say how much of the loss of jetty height is due to each of the two causes of settlement, but it is evident that had the brush been properly protected from the attack of the teredo, as it might have been had funds been provided for the rapid and complete execution of the work, but little loss would have to be ascribed to this cause. As it is, the bulk of our loss must be attributed to the teredo.

Very respectfully, your obedient servant,

S. M. MANSFIELD,
Major of Engineers,
Bvt. Lieut. Col., U. S. A

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. JOHN M. PICTON, ASSISTANT ENGINEER.

GALVESTON, TEX., *November* 6, 18

COLONEL: I have the honor to make the following report upon examinatio south jetty at Galveston to ascertain cause or causes of its subsidence and its gen condition.

According to instructions contained in your letter of August 19, 1885, I made prep tions to commence work of boring into the jetty at various points along its Assuming that the mattress work had not been entirely destroyed, it was propos penetrate the work in the following manner: Three or four iron piles were driven into the jetty about 6 feet apart, a scaffolding erected upon them, stone moved from top of jetty inside of square or triangle by means of a diver, heavy cutting tools shaped somewhat like spades with cutting edges all around brought into requisition and worked from scaffolding to cut through to next layer. Battens to serve as guides for the same to be lashed near crest of jett piles, and after the diver had removed débris, care to be observed in examinin material and noting depths from which it was taken.

BORING NO. 1.

For convenience of comparison the point selected for making first boring wa Section No. 1 (Ripley's, made June, 1885), 581 feet from outer end and 10 feet of axis of jetty, where its base was 120 feet, and four courses of mattress work been placed. Three iron piles were driven into the jetty, 6 feet apart, a scaffol erected upon them, battens placed and lashed, and after removal of stone by d cutting tools were worked vigorously, but owing to the presence of sand, shell, small stone throughout the brush work, they were found of no use for the pu for which they were intended, so were abandoned. After working upon this August 26, September 3, 10, and 11, removing material with diver, and gaining little in depth, owing to quicksand and fine shell, it was decided to try dynam hasten it to completion. Before next favorable day the storm of 17th, 18th, and September had filled excavation and stripped the piles, leaving them bent, but Dynamite was used in small charges September 23, 27, and 28, when a depth of feet mean low tide was reached, and nothing but sand and shell could be found inches below. This boring was then considered completed, the sand bottom been reached, and the results of the work at this point are as follows:

	Feet.
Depth on rock	7.1 mean low
Depth on upper brush-work or compacted mass, brush, fine shell, and sand	9.5 mean low
Depth on rock	11.5 mean low
Depth to sand bottom	11.6 mean low

Rock from crest of work was covered with small unoccupied oyster-shell and pa of pinkish and white coral; below sand and shell filling it was discolored bla addition.

Brush-work had lost its identity as mattress-work throughout, but was stronger near crest, gradually growing weaker as depth of excavation increased, and one piece of brush was found occupied by teredo.

Cane was found in lower work, soft and with little strength, though free from signs of teredo.

Creosoted oak stakes in top of brush-work were damaged by worm at their tops only, the lower imbedded parts being sound.

Below level of sand and shell filling the jetty was a compact mass of sand, shell, stone, and brush in various stages of decomposition.

Referring to the records of placing, it is found that at this point the foundation course was laid December 23, 1881, second course January 19, 1882, and third and fourth courses August 8, 1882, and that, owing to some damage done to upper work, 287.95 cubic yards of riprap was distributed here over a length of jetty crest of 150 feet on October 9, 1882. The depth upon the sand bottom when foundation mattress was placed is found to be 11.8 feet mean low tide, upon ballast of foundation mattress 9.8 feet mean low tide, and upon upper rock at time of placing fourth course at this point a depth of 2 feet mean low tide (approximately).

A rock was found in this boring at a depth of 11.5 feet mean low tide, and although probing a few inches below failed to discover anything but sand and shell, still the location of the bottom of the jetty is not positive as at other bores, so no comparison for settlement of lower mattress is made. The depth upon top rock at point of boring upon placing of fourth course (2 feet mean low tide), compared with 7.1 feet mean low tide, the present depth, gives evidence of a loss in height of work at this point (7.1 feet — 2 feet = 5.1 feet) of 5.1 feet, or (5.1 feet ÷ 9.8 feet = .520) about 52 per cent of original elevation.

Use of dynamite was abandoned, owing to fear of disturbing work to such an extent that its condition could not be determined accurately.

BORING NO. 2.

This was located 7 feet north of axis and 19,467 feet from outer end of jetty, where its base is 60 feet and three courses of mattresses had been laid and through all of which it passed. On September 29 an iron pile was driven to mark point of boring and a triangle, formed by lashing three iron cutting-tools together, lowered down upon rock top of jetty (with one corner lashed to pile) to serve as guide for diver, when work of removing and examining material was commenced. Progress was slow, owing to great strength of ebb currents across the jetty, which dragged our barge anchors and against which diver could not stand. Work was continued September 30, October 1, and on October 3 the sand below the jetty was reached at a depth of 5.9 feet mean low tide. Probing 1 foot deeper failed to find aught but sand. At this point we have:

	Feet.
Depth on rock	2.6 at mean low tide.
Depth on brush (second course ?)	4.2 at mean low tide.
Depth on sand and shell covering	4.4 at mean low tide.
Depth on brush foundation mattress	5.1 at mean low tide.
Depth to sand bottom or bottom of lower mattress	5.9 at mean low tide.

Rock on top of jetty was covered with brownish mossy slime and oysters (some few alive), but in body of work it was simply discolored with black slime.

Brush ends projecting above upper rock, though for most part abandoned, were well eaten by teredo to the point of entering sand and shell filling; below this plane the brush (pine) was strong, tough, and untouched by worm. Even the pine leaves were perfectly preserved, and what appeared to be sprouting cane was found at or near top of foundation mattress.

It was observed by diver that three layers each of brush and stone were passed through.

From the office records I find that at this point the foundation course of work was placed May 24, 1882; second course, February 20, 1883; and third course, April 28, 1883. Upon the said bottom at time of placing foundation mattress there was a depth of 6 feet mean low tide, and rock ballast of upper work at this point projected above plane of mean low tide 1.5 feet. Comparing height of work here in 1883 and the present time, a loss (2.6 feet + 1.5 feet = 4.1 feet) of 4.1 feet, or (4.1 feet ÷ 7.5 = .546) about 55 per cent. of original height, is evident; and a comparison of depths upon sand bottom now and at time of placing foundation mattress shows that no bodily settlement has taken place, the slight difference being no doubt due to crude manner of making borings.

BORING NO 3.

Boring No. 3 was made on line of Section No. 1 (Ripley's), 32¼ feet south of axis a 581 feet from outer end of jetty on October 5. The information obtained was:

	Feet.
Depth on rock	12. 9 at mean low
Depth upper brush	14. 6 at mean low
Depth to sand bottom or bottom of lower mattress	16. 5 at mean low

Rock removed from this point had considerable coral and oyster shell attached. a creosoted oak stake found in brush work was strong, though well eaten and ab doned, and its exposed portion was almost entirely covered with a hard coralline crustation.

Brush at this point (pine) was well eaten, but had considerable strength nea of jetty, and was partly occupied by teredo.

Cane found at depth of about 16 feet, mean low tide, was untouched by worm quite well preserved. As only two courses of mattresses were laid here original the foundation and fourth courses—and cane was used only in the former, we h evidence that this boring passed through both courses.

Sand filling extended very little above the bottom of jetty at this point.

Records show the foundation mattress to have been placed December 23, 1881, a depth upon original sand bottom of 12.2 feet mean low tide, and fourth course tress August 8, 1882, with 5.9 feet (approximately) mean low tide upon its rock last at point of boring. A comparison of depths on sand bottom in 1881 and present time (16.5 feet — 12.2 feet = 4.3 feet) shows a bodily settlement of 4.3 feet this point (32¼ feet south of axis), and taking depths upon rock now and in 188 find a subsidence (12.9 — 5.9 = 7 feet) of 7 feet of the top of upper course.

BORING NO. 4.

This boring was made October 6, 1885, on line of Section No. 4 (Ripley's), w jetty has a base of 90 feet, and only passed through the south foundation mat It is distant from outer end 6,690 feet, and 30 feet south of axis of jetty, and furn the following data:

	Feet.
Depth on rock	15. 6 at mean low
Depth to sand bottom or bottom of lower mattress	16. 9 at mean low

Rock here was covered with oyster shell, barnacles, and largest coral met with to these some rock added a thin, hard, coralline encrustation. The softer sands showed evidence of perforation by something.

Brush was all weak, honeycombed, and abandoned, and the layer was only inches in thickness.

Cane found was wormed, and had lost most of its strength.

There was, according to the records, a depth of 11.4 feet mean low tide upon sand bottom at time of placing foundation mattress (July 30, 1881), upon whose ballast there was a depth of 9.2 feet mean low tide. Making a comparison of de of 16.9 feet and 11.4 feet we have a bodily settlement of this mattress amounting (16.9 — 11.4 = 5.5 feet) 5.5 feet.

BORING NO. 5.

This one was located on line of Section No. 3 (Ripley's), 38 feet south of axis 4,204 feet from outer end of jetty, where its base is 90 feet (60 feet south and 30 north of axis), and passed through the south foundation mattress only. At this p I find:

	Feet.
Depth on rock	19. 6 at mean low
Depth to sand and mud bottom or bottom of mattress	20. 6 at mean low

Only a few rock with some oyster shell and small coral attached were found.

Brush layer was thin, weak, honeycomed, and partly occupied by teredo.

Referring to records of placing, it is seen that this mattress was placed Marc 1882, with a depth upon sand bottom at that time of 14.8 feet mean low tide, wh by comparison with present depth (20.6 feet — 14.8 feet = 5.8 feet) shows a set ment bodily (of this mattress) of 5.8 feet.

BORING NO. 6.

Boring No. 6 was located on axis of jetty, 6,713 feet distant from its outer end and 23 feet shoreward from Section No. 4 (Ripley's), where base of work is 90 feet, and four courses of mattress were laid. The following data were obtained:

	Feet.
Depth on rock	8.4 at mean low tide.
Depth on rock, second course	9.6 at mean low tide.
Depth on brush, second course	10.1 at mean low tide.
Depth on sand and shell covering	10.1 at mean low tide.
Depth to sand bottom or bottom of lower mattress	11.8 at mean low tide.

The rock at this point was well covered with barnacles, oysters both dead and alive, some coral, and reddish discolorations. Coral was largest on second-course rock; and the softer sandstone, though free from attachments, showed evidences of perforation, as before mentioned.

Brush of upper work was weak, honeycombed, and abandoned, but that just below second-course rock was better and mostly unoccupied; lower brush was tough and sound, having only an end eaten now and then before teredo had abandoned its work. Below sand and shell filling it is practically uninjured.

The cane found in lower work was unhurt by worm, but had little strength.

Upon locating the depth of bottom of jetty a depth of 13.8 feet mean low tide was reached by probing without discovering more brush or stone.

From the records I find that the foundation course was placed here July 29, 1881; second course, June 29, 1882, and the third and fourth courses, December 17, 1883. The depth upon sand bottom at time of placing foundation-mattress was 11.4 feet mean low tide, which, by comparison with depth upon sand bottom at present (11.8 feet—11.4 feet=.4 foot), shows a bodily settlement of jetty of .4 of a foot. The depth upon the rock ballast of fourth course at this point, when placed, was 1 foot mean low tide (approximately). Making a comparison for subsidence of top rock, we find (8.4 feet—1 foot=7.4 feet) a loss in height of 7.4 feet, or (7.4÷10.4=.712) about 71 per cent. of original elevation.

BORING NO. 7.

This boring was made October 16 and 17, and was located 10,068¼ feet from outer end and 8¼ feet north of axis of jetty, where its base is 90 feet, and three courses of mattresses were laid.

It passed through foundation and third courses only, the former of which was easily traceable. From note-book the following is taken:

	Feet.
Depth on rock	5.4 at mean low tide.
Depth on foundation rock	6.6 at mean low tide.
Depth on foundation brush	7.2 at mean low tide.
Depth to sand and shell covering	7.1 at mean low tide.
Depth to sand bottom or bottom of lower mattress	8 at mean low tide.

Oysters, dead and alive, some coral and yellowish discolorations covered the rock removed from top of jetty; all rock below top of sand filling discolored black. More perforated sandstone was found here.

Upper layer brush was thin, honeycombed and weak, but that in foundation was strong, tough, and well preserved. The teredo had commenced but abandoned its work.

Cane was found at top of foundation-mattress untouched by worm, but soft and weak.

Reaching the bottom of jetty, probing to a depth of 9.2 feet, mean low tide, proved that nothing but sand was below.

Referring to the records it is found that foundation-mattress through which this boring passed was placed June 1, 1881, in a depth of 8.3 feet mean low tide (with the tide record of that day questioned as being in error); a comparison of the depths on sand bottom is not satisfactory, as it shows a less depth now than in 1881, which, no doubt, is attributable to the dubious tide record. The upper mattress at this point was placed July 23, 1881, but the depths upon its top is not given, so no comparison for subsidence of top of jetty can be given either at this point or near it.

BORING NO. 8.

This consumed October 24, 27, and 29, and was located 9¼ feet north of axis and 598¼ feet from outer end of jetty, where its base is 120 feet, and four courses of mattresses were laid, all of which were passed through in this boring. At this point I found—

	Feet.	
Depth on rock	7.8	at mean low tide.
Depth on upper brush	8.7	at mean low tide.
Depth on brush, second course	9	at mean low tide.
Depth on sand and shell covering	9	at mean low tide.
Depth on rock, foundation	10.1	at mean low tide.
Depth on brush, foundation	10.9	at mean low tide.
Depth sand bottom or bottom of lower mattress	12	at mean low tide.

The rock on top of jetty was more or less covered with oyster shell, small coral, and encrustation; that from lower work with oyster shell and barnacles, and discolored black.

The upper brush on that of third and fourth courses was honeycombed and abandoned, and had little strength; that of the second course was eaten by teredo near the top only; and foundation-brush was well preserved, strong, and practically as good as when placed.

Creosoted oak stakes were found in upper work well eaten from their tops to point of entering the sand and shell filling. Below that plane they were sound and untouched by worm.

Cane was found between depths of 9 feet and 10.1 feet mean low tide (indicating the presence of second-course work), but was soft and weak.

A depth of 12.8 feet mean low tide was reached by probing in this boring, or .8 of a foot below bottom of jetty.

According to the records of placing there was, depth upon the sand bottom, at time of placing foundation-mattress (December 23, 1881), of 11.8 feet mean low tide, which compared with depth at present time, gives a settlement of .2 of a foot at this point. The second course was placed January 19, 1882, and the third and fourth courses August 12, 1882, with a depth upon upper rock at this point of 2 feet mean low tide (approximately); this depth, compared with present depth (7.8 feet — 2 feet = 5.8 feet) shows a loss in height here of 5.8 feet or (5.8 feet ÷ 9.8 feet = .592) 59 per cent. original work. Records also show the placing of 287.95 cubic yards riprap along 150 feet of jetty crest here, to repair damage done to upper work on October 9, 1882.

BORING NO. 9.

Boring No. 9 was only partly completed and consumed October 30, November 2, and part of November 3. Its location is 3 feet north of axis and 2,522 feet from outer end of jetty where base is 120 feet, and four courses of mattresses were laid. Here I obtained the following:

	Feet.	
Depth on rock	8.7	at mean low tide.
Depth on upper brush	9.1	at mean low tide.
Depth on sand and shell covering	9.5	at mean low tide.
Depth on brush, second course (?)	9.6	at mean low tide.
Depth on rock (foundation course ?)	10.5	at mean low tide.
Depth on brush (foundation course ?)	11.1	at mean low tide.

The rock at this point was covered with barnacles, oyster shells, coral, reddish and yellowish discolorations and encrustation in upper work, but lower down had only a few barnacles and oyster shells attached.

The upper brush was better and stronger than before found so near top of jetty, though it was well wormed and partly occupied by teredo; below the level of sand and shell filling it was damaged very little, and for the most part was in an excellent state of preservation.

From the records it is found that the depth upon the sand bottom at time of placing foundation-mattress was 11.6 feet mean low tide, but as the bottom of the jetty was not located in this boring no comparison for settlement can be made. The depth upon rock of fourth course at time of placing is not given in the records, but at the nearest point of sounding, 207 feet west of this boring, it is found to have been 2¼ feet mean low tide (approximately); and assuming height of work to have been the same here (which is probable), and making a comparison for subsidence of top of work (8.7-2.25 = 6.45) we find a loss of 6.45 feet or (6.45 ÷ 9.35 = .69) about 69 per cent. of original height of work at this point.

The foundation-course was placed October 31, 1881; second course, February 2 1882, and third and fourth courses, October 26, 1882; and, owing to damaged upper work on November 14, 1882, 123 cubic yards of riprap was distributed over a length of [illegible] feet of jetty crest to repair the same.

Examinations were made to determine positions of south mattresses at sections Nos. 1, 3, and 4, and are reported upon in borings Nos. 3, 4, and 5. The following indicates the position of the south mattress at section No. 5, and gives results of a further investigation at section No. 1. The mattress at former place was found covered with sand, and, probing with force-pump nozzle attached to a sounding pole, I found—

On section line, 27 feet south of axis: Depth mean low tide 14 feet, hard sand; 17.7 feet, rock.

On section line, 32 feet south of axis: Depth mean low tide 14½ feet, hard sand; 17.5 feet, rock.

On section line, 40 feet south of axis: Depth mean low tide 15.2 feet, soft sand; 17.5 feet, rock.

Comparing this with the position of mattress when placed (see section No. 5, Ripley's) it is evident that a settlement of about 10½ feet and a sand filling of from 2 to 3 feet has taken place.

At section No. 1 rock could not be felt beyond a point 34 feet south of axis of jetty, and probing into sand failed to find either brush or rock of south mattress here. At this point I had—

On section line, 40 feet south of axis: Depth mean low tide 16.6 feet, sand; no rock or brush 21 feet.

On section line, 36 feet south of axis: Depth mean low tide 15.9 feet, sand; no rock or brush 21 feet; which shows that this mattress must either have settled a great deal or been carried away.

The following is a résumé of contents of reports upon borings on or near axis of jetty:

Boring.	Distance north from axis.	Distance from outer end of jetty.	Bodily settlement.	Subsidence of top of work.	Original thickness of work.	Loss in height, per cent., of original work.
	Feet.	*Feet.*		*Feet.*	*Feet.*	
No. 1....	10	581	....	5.1...........	9.8...........	.520
No. 2....	7	19,467	+.1	4.1...........	7.5...........	.546
No. 6....	0	6,713	−.4......	7.4...........	10.4...........	.712
No. 7....	8½	10,068½	+.3	....	....	
No. 8....	9½	598½	−.2...........	5.8...........	9.8...........	.592
No. 9....	3	2,522	....	6.45...........	9.35...........	.690
Mean			.6 − .4= .2+4=.05 foot.	28.85+5=..... 5.77 feet.....	46.85+5....... =9.37 feet....	3.060+5= .612 per cent.

It will be seen from above table that four borings give us an average settlement bodidly of .05 of a foot, five give a mean subsidence of top of 5.77 feet of work of average height of 9.37 feet, or an average loss of .612 per centum of original height of work at points of boring.

At borings Nos. 1, 8, and 9 the upper work is known to have been damaged, but only at No. 1 was more rock than usual noticed upon top of jetty. At point of greatest loss, boring No. 6, one year and a half elapsed between the placing of second and third and fourth course work, which may account for loss above the average.

The sand and shell only partly filled the work, but the condition of the brush above and below its top proves beyond doubt that where covered it will be well preserved and safe from attacks of teredo. It was noticed that to a great deal of this sand and shell filling was added the shell left in wood by teredo, proving, I think, a considerable destruction of upper uncovered work. The loss in height of jetty shown by these borings is greater than the actual loss, as it was found that the greater part of upper rock had been driven north of its axis, as shown by Mr. Ripley. In the lower and sound work it was not difficult to trace the courses laid, but near the top of jetty it was impossible to do so, and consequently some reliance had to be placed upon statements of diver.

In the accompanying diagram all the borings are shown, the layers of work as placed and as found by me being placed side by side for comparison. Boring No. 1 was not entirely satisfactory for some inexplicable reason, but leaving that aside all the foundation brush on or near axis is perfectly preserved and sound, and in many cases the second course also.

The percentage of loss in height due to teredo cannot be given, as it is not possible from this examination to separate the subsidence due to destruction of brush from that due to compression. Nor can the exact compression be determined, owing to likelihood of missing rock upon foundation mattress and the variation of depths taken upon the uneven surface of stone; hence the apparent lack of reliable data.

Although practically no settlement has taken place along jetty axis, it may be seen, by reference to borings Nos. 3, 4, and 5 on diagram, that considerable has taken place upon its edges.

Coral has formed upon nearly all of the top rock and some (of which you have sa ples) has attained quite a growth for the short time the insect has been at work. O ters have attached themselves to the rock, but few are now alive. I am unable to a count for perforations of rock, as it was not inhabited, except by very small c when brought up.

CONCLUSIONS.

As to the causes of the loss in height of the south jetty, it is my opinion that th are two in number only, destruction of unprotected upper work by teredo and c pression; bodily settlement does not enter into the question. Just how much los due to each of these causes this examination fails to decide, but it is quite evid from the sound condition of the lower brush-work and unsound condition of up work that more is due to destruction of upper brush by teredo than to compress

Very respectfully, your obedient servant,

JOHN M. PICTON,
United States Assistant Engine

Maj. S. M. MANSFIELD,
Corps of Engineers, U. S. A.

S 2.

IMPROVEMENT OF SHIP-CHANNEL IN GALVESTON BAY, TEXAS.

Original estimate (for channel 100 feet wide and 12 feet deep), 1877	$446,3
Appropriated, 1872 to 1886*	446,5

ORIGINAL CONDITION OF THE LOCALITY.

In 1871 the natural channel through the bay had a depth of not than 7 feet at the shoalest places, the average depth 8½ feet, with b tom of soft mud, sand and shells.

PROJECT FOR IMPROVEMENT.

Estimate of 1877 (modifying that of 1871) was $446,326.42, with wh sum it was proposed to deepen and widen the channel from the head Bolivar Channel to the cut through Morgan's Point, to afford a ch nel 12 feet deep at mean low tide, with a width at bottom of 100 feet.

OPERATIONS PRIOR TO JUNE 30, 1886.

During 1872, 1873, 1874, 1875, and 1876, in 1879 and 1889, and in 1 and 1883, by contract and by Government machinery, dredging w carried on through Red Fish Bar and in the lower and upper bays, work resulting in a navigable channel of 8.9 feet at mean low tide fr Bolivar channel to Morgan's Cut. The amount of money expended this work was 286,629.50.

No work has been done since 1883, owing to the reserving of t available funds for Congressional action, "because of the probabil that the improvement demanded could not be made a permanent one any reasonable cost; that the cost of maintenance would be relativ excessive; that the necessity for the channel was far less than former and that it was not called for in the interests of commerce for the pre ent."

It was provided in the act of July 5, 1884, that the money in ha should not be expended until the Secretary of War be satisfied that t Buffalo Bayou Ship-Channel Company has relinquished or abandoned the United States forever all the franchises and any and all right to collect or impose tolls or charges from any part of said ship-channel or Buffalo Bayou.

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* Last appropriation, 1882.

The views suggested in letter of August 7, 1884, Office of the Chief of Engineers, viz, to call upon the stockholders of the Buffalo Bayou Ship-Channel Company for their consent to the surrender and transfer of their charter, &c., to the United States, were complied with by letter from this office August 13, 1884. On the 14th of October, 1884, Mr. Cave, the president of the company, in reply, stated that the matter was having full consideration. Since then nothing has been heard of the matter, and, in so far as this office is concerned, the subject remains in abeyance.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1887.

The action of Congress upon this work in the pending river and harbor bill will decide active or inactive operations for the year.

The work is in the collection district of Galveston. The light-houses on or near the line of work are at Bolivar Point, at Fort Point, at Half Moon Shoal, at Red Fish Bar.

COMMERCIAL STATISTICS.

The commercial statistics are to be found with the report of the improvement of Buffalo Bayou, Texas.

Money statement.

July 1, 1885, amount available	$159,870 50
July 1, 1886, amount available	159,870 50

S 3.

IMPROVEMENT OF TRINITY RIVER, TEXAS.

Estimate of 1880, dredging bar and removing snags above and below Liberty, and dredging bar at the mouth of Middle Pass	$36,541
Appropriated 1880–1886	*22,000
Balance of estimate	14,541

ORIGINAL CONDITION OF THE LOCALITY.

In 1879 the river above Liberty, the head of tide water, 41 miles from its mouth, was a succession of rock and gravel shoals, with deep pools between, very tortuous, and obstructed by water-logged snags, which were not carried off during high stages of river. Below Liberty the character of the river was entirely different. Between Liberty and Moss Bluff it varied in width from 200 to 275 feet and in depth from 5 to 30 feet, with the exception of a bar, with 2 feet water over it, 4½ miles below Liberty. From Moss Bluff to the mouth of the river it opened out to 500 feet in width and a depth of from 10 to 45 feet, free from any obstruction. It flowed into Galveston Bay through four principal channels and a number of small bayous. About 4½ feet could be carried across the bar at the mouth of the river in the best natural channel.

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*Appropriated 1878, 1879, $12,500, making a total of $34,500 appropriated 1878–1886.

PROJECT FOR IMPROVEMENT.

The estimate of 1871–'73 was $46,000 for pile breakwater, dredging, removing snags, &c., to secure a channel for navigation of 5 feet draught from the mouth up to Liberty.

OPERATIONS FROM 1880 TO JUNE 30, 1885.

1. *Contracts with Seth N. Kimble, of June* 10 *and November* 14, 1879.–Forty-seven thousand three hundred cubic yards of material were re-moved from the entrance bar, leaving a dredged channel of not less than 5½ feet depth, averaging 110 feet width, and in length across the bar 4,800 feet. Work done in June and July, 1880.

2. *Contract with G. L. Long, of July* 25, 1881.—Two thousand nine hundred cubic yards of sand were removed in making a cut 85 feet wide and 7 feet deep through a bar located about 4 miles below Liberty; also 33 snags and 25 overhanging trees were removed and the river cleared of other obstructions for that portion between its mouth and Liberty. Work done in April, 1882.

3. *Contract with John J. Atkinson, of October* 15, 1884.—A sheet-pile revetment was built across the bar at the mouth of Middle Pass and a channel dredged alongside of it. The length of revetment was 2,7 feet, its top in a plane 4½ feet above the surface of mean low tide. The dredging amounted to 23,275 cubic yards, the material being satisfactorily disposed of behind the revetment and in other suitable places. Work was done between November, 1884, and April, 1885.

The amount expended upon these improvements, including superintendence and contingencies of office, was $33,993.50, and resulted in temporarily opening the river to navigation so as to admit vessels of feet draught.

No funds were available, and work of improvement did not continue through any part of the last fiscal year. The condition of the improvement at the end of the year (June 30, 1886) was about the same as reported last year, with the exception that the revetment received some damage along the upper wing where open to scour and heavy seas. No complaint is made of want of depth of water in channel, and to all appearances the demands of commerce and navigation, for a while at least, have been satisfied.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1887.

There being no adequate funds available, no work is possible during the year.

The balance of the estimate of 1880, $14,541, could be profitably expended in the fiscal year ending June 30, 1888, in continuing work of improvement originally intended.

There exists no basis for estimating the length of time the cuts made through the bar at the mouth and the bar at Liberty will remain open for navigation, or of the cost of maintaining the river from its mouth to Liberty in a navigable condition.

The work is located in the collection district of Galveston. Nearest light-house, Red Fish Bar, Galveston Bay.

COMMERCIAL STATISTICS.

Commerce is small, and consists of cord-wood and charcoal and some saw-logs and timber. One or two small mills are located on the river.

	Pounds.
Lumber	1,025,772
Oil	1,021,854
Coal	9,105,600
Gas-pipe	631,680
Cotton-seed cake	31,185,280
Total	159,780,450

L. MEGGET,
Secretary.

S 5.

IMPROVEMENT OF THE MOUTH OF BRAZOS RIVER, TEXAS.

Estimate for jetties, 1880	$522,890 44
Appropriated, 1880–'86	140,000 00
Balance of estimate	382,890 44

ORIGINAL CONDITION OF THE LOCALITY.

The river debouches into the Gulf of Mexico through a single natural outlet and preserves a nearly uniform width and depth from the coast for several miles up-stream, the width averaging from 500 to 600 feet, the depth from 15 to 18 feet. The bed of the river is soft mud; the banks, except at a few points, being above overflow. A bar had formed at the mouth of sand drifted along the shore and driven in by the sea.

The crest of the bar was about three-eighths of a mile from the shore-line, and the channel across afforded a variable depth of water for navigation of, at times, not over 8 feet (in October, 1874 only 2½ to 3 feet), being subjected to changes due to winds, tide, and stages of water in river.

PROJECT FOR IMPROVEMENT OF THE BAR-CHANNEL.

The project was originally adopted in 1880, and looked to the amelioration of the channel over the bar by the use of jetties, the positions of the jetties to be determined by the local engineer upon the general principle that they should be parallel, or nearly so, that they should terminate in 18 or 20 feet water, and that their position be so chosen as to fix the channel in its natural direction. Approximate length of north jetty, 3,600 feet; of south jetty, 4,350 feet. Estimated cost, $522,890.44.

OPERATIONS FROM 1880 TO JUNE 30, 1885.

North jetty.—This work was built out from shore a total length of 2,433 feet, the inner portion for some 600 feet near shore-line being raised above the plane of high water, the outer portion being submerged an average of 4 feet below level of mean low tide.

South jetty.—This work was extended 700 feet, a foundation course of mattresses commencing at a point 2,000 feet distant from shore running on a curve to the eastward, leaving the distance between the jetties 720 feet.

The jetties were constructed of brush mattresses andconcrete ballast, $139,654.47 having been expended in the operation. The result of this expenditure has caused the channel to be improved both in direction

and depth, and in every way sufficient for the coasting trade having
lation with the port.

No funds were available for the past fiscal year, and no work was do

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 18

Eighteen thousand seven hundred and fifty dollars will enable th placing of about 5,000 cubic yards of material in the work. To contin work in running out top course of north jetty and making minor rep to old work it is estimated that 1,750 tons of concrete and 5,500 cu yards of brush-work may be placed, which will in a measure augm jetty proportions and tend to keep the improvement from deteriorat

During the fiscal year ending June 30, 1888, there could be profita expended $100,000 (the annual estimate) in continuing jetty constr tion in accordance with the adopted plan.

The work is located in the collection district of Galveston, and the nearest li house is at the entrance to Galveston Harbor.

COMMERCIAL STATISTICS.

No reliable statistics can be furnished. The commerce of this river that pass and from the Gulf is insignificant.

Money statement.

July 1, 1885, amount available	2
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1
July 1, 1886, amount available	2
Amount appropriated by act approved August 5, 1886	18,7
Amount available for fiscal year ending June 30, 1887	18,9
Amount (estimated) required for completion of existing project	364,1
Amount that can be profitably expended in fiscal year ended June 30, 1888	100,0
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

S 6.

IMPROVEMENT OF PASS CAVALLO, INLET TO MATAGORDA BAY, TE

Estimate, south jetty and groins for shore protection, 1879	$1,0
Appropriated, 1876-'86	29
Balance of estimate	7

ORIGINAL CONDITION OF THE LOCALITY.

The pass forms the connection between the Gulf of Mexico and large inland basin (approximate area 520 square miles), compris Matagorda Bay, Espiritu Santo Bay, San Antonio Bay, and numer small bays further inland and connecting with these. Its history, that of other entrances on this coast, showed a steady deterioration harbor and a constant shifting of the channel to the south and west. bar, composed of loose shifting sand and fully exposed to the actio storms, permitted entrance of vessels drawing not more than 8 feet, the ever-varying channel having a depth of from 7 to 9 feet.

PROJECT FOR IMPROVEMENT.

To extend one jetty from the head of Matagorda Island, in a south-easterly direction, and construct groins for shore protection whenever necessary, jetty and groins to be of brush-mattress work, ballasted with concrete and stone. Object of work, to obtain a 12-foot channel across the bar. Estimated cost, $1,039,280.

OPERATIONS FROM 1880 TO JUNE 30, 1885.

South jetty.—This structure, on the 30th of June, 1885, had in its foundation and superposed courses 48,934.53 cubic yards of brush mattresses and concrete and stone ballast, the total length of which approximated 5,253 feet. About 1,400 feet of the shore end was raised above mean low tide, the remaining 3,853 feet of jetty being submerged. The work followed that outlined in approved project. Amount expended upon this work to June 30, 1885, was, including superintendence and contingencies, $267,816.95, and resulted in giving the channel permanency in position, together with a decided improvement in depth across the bar in a direction suitable for navigation.

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1886.

An extension of time for completing the contract of September 6, 1884, with A. M. Shannon & Co., had been granted by the Chief of Engineers to September 30, 1885. By the 28th of July the contractors had completed their work, having added to jetty 4,027,636 cubic yards of brush mattress work and 1,131.5 tons of stone ballast. The work was satisfactorily performed. It consisted in placing an aggregate of 14,566,616 cubic yards of brush and stone in the jetty at a total cost of $47,851.97 (paid contractors), or $3.28½ per cubic yard.

The object of this work looked to giving the south jetty (the only work) larger proportion, with a view to throwing a more concentrated outward current upon a limited extent of bar to develop a deeper channel thereon, and incidentally, by further work as appropriations are made available, slowly approach the consummation of the desired improvement.

For the reason that the funds remaining in hand, after the completion of A. M. Shannon & Co.'s contract, July 28, were the residue applicable to superintendence and contingencies of office, no work was done the rest of the year.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1887.

The present jetty work, although incomplete in lengh and height for permanent improvement, strengthens the expectation of a thorough improvement when the jetty reaches proportions necessary to that end. Fifty thousand dollars will cover the cost of 15,000 yards of brush and stone work in the jetty; successive layers to raise the work to a higher plane. An examination prior to rendering project for continuing this improvement will be made, so that the money may be expended in the most profitable manner upon a basis conforming in a measure with the funds granted by Congress for this work.

During the fiscal year ending June 30, 1888, there could be profitab expended $200,000 (the annual estimate) in continuing the building the south jetty in accordance with the approved plan.

The work is located in the collection district of Indianola, Tex., and near Ma gorda light-house.

Money statement.

July 1, 1885, amount available	$22,13
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	20,14
July 1, 1886, amount available	2,034
Amount appropriated by act approved August 5, 1886	37,50
Amount available for fiscal year ending June 30, 1887	39,534
Amount (estimated) required for completion of existing project	1,366,75
Amount that can be profitably expended in fiscal year ending June 30, 1888	200,00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, INDIANOLA, TEX.,
Collector's Office, July 20, 18

DEAR SIR: In answer to yours of July 5, 1886, will say that there were no for entrances or clearances for the fiscal year ending June 30, 1886.

There were ten entrances of steamships and two of schooners coastwise for s period, aggregating 7,519.17 tons; no clearances.

The present business of this district is done at Eagle Pass and Del Rio, on the Grande, as the arbitrary rates charged on freights by rail to the interior from port prevents water transportation to this place. This action on the part of the r road officials tends to injure and will finally destroy every port on the coast of Te if not stopped by legislation, as the bent of all railroads is to get the long haul.

Hoping this information, small in itself, is what you desire,

I remain, yours, &c.,

OTTO L. THREEKELD,
Collect

Maj. S. M. MANSFIELD.

S 7.

IMPROVEMENT OF ARANSAS PASS AND BAY UP TO ROCKPORT AND CO PUS CHRISTI, TEXAS.

Estimate for jetties, groins, shore protection, &c., 1879	$759,18
Estimate for dredging, &c., in the bay, 1879	441,53
	1,200,72
Appropriated, 1879–1886	380,00
Balance of estimate	820,72

ORIGINAL CONDITION OF LOCALITY.

The pass forms connection between the Gulf of Mexico and Ara and Corpus Christi bays, and its history, like other entrances on coast, shows a constant movement of its channel to the south, with gressive shoaling therein and enlargement of the Gulf Bar, which, posed of fine shifting sand, &c., crowns the entrance at a distan about three-fourths of a mile from shore. Across the bar during the year preceding the commencement of the work of improvement the best water available for navigation was 5 to 5½ feet, and this in a channel constantly changing its position. In the interior channels the depth afforded for navigation up to Rockport and Corpus Christi was about 8 feet.

PROJECT FOR IMPROVEMENT.

To extend jetties from the south end of Saint Joseph's Island and the north end of Mustang Island, contracting the width of water-way out to a sufficient distance to afford a draught of 12 feet at mean low tide over the bar, and to construct groins, in conjunction with a beach flooring of mattresses, for the protection of the head of Mustang Island up to and beyond Turtle Cove, and to plant trees upon Saint Joseph's Island for its protection against abrasion by winds.

Estimated cost of jetties, groins, &c., $759,185.

In the matter of improving the interior channels for navigation from Aransas Pass up to Rockport and Corpus Christi, the discussion of the problem was left to wait upon the protection of the islands from abrasion and upon the success of the attempt to increase the depth over the bar to 12 feet.

(Estimated cost, Major Howell, 1879, $441,537.75.)

OPERATIONS FROM 1880 TO JUNE 30, 1885.

1. *Protecting head of Mustang Island up to and beyond Turtle Cove.*—This was effected by the construction of seven groin-jetties, built on the west side of the pass, with a breakwater and revetment along the channel-face of Mustang Island.

2. *Protecting channel from drifting sand.*—This by means of a number of sand-fences built on Saint Joseph's and Mustang Island.

3. *Sustaining outward current for effective work in bar-channel.*—This was being accomplished by the construction of a jetty on the south side of the channel, running from Mustang Island into the Gulf in an easterly direction. The total length of this jetty was 5,500 feet, of which 1,500 feet was shore-work and 4,000 feet jetty-work proper. From extreme inshore end the work was raised above overflow by ordinary high tides for a distance seaward of 3,300 feet, the outer 2,200 feet being submerged 3 to 14 feet below mean low-water level, or 7 feet on an average.

The groins, breakwater, revetment, and jetty were constructed of brush mattresses and stone ballast. The high portion of jetty—inshore superstructure—was obtained mainly by a pile system and stone topping, and was merely intended as a temporary structure to catch and hold the drift-sand until such time as the money in hand would warrant the making of such structure more substantial. The amount expended, including contingencies and superintendence, to June 30, 1885, was $383,025.82, of which amount $9,938.93 was subscribed by private parties. The resulting effect of this expenditure was the securing of the head of Mustang Island and the developing of a good straight channel across the bar, carrying a depth of 11 feet at mean low tide.

PROGRESS MADE DURING THE YEAR ENDING JUNE 30, 1886.

The only available funds in hand July 1, 1885, were those left from the appropriation of July 5, 1884, amounting to $6,913.11. This sum was held in reserve to be applied to the preservation of the work by supplying deficiencies and losses which might occur from time to time through the action of the sea, and in making any needed repairs, and also for contingencies of office and care of plant.

In the latter part of August it was discovered that certain piles at the outer end of the finished work had become weakened by the action of the teredo. It was considered advisable to replace the weak piles by sound ones (square timber charred and tarred) and to further secure the work by additional stone. Preparation was made, work authorized by hired labor and open purchase, and work of repair commenced the last week in the month, and was continued until the 16th of September, at which time the outer end of the superstructured work was well bulkheaded and secured against, as it was thought then, even a more than ordinary storm. It was expected that this work of repair would continue until all the weakened piles found further inward would be replaced by sound ones; but on the 17th, and during the 18th and 19th of September the severity of the weather hindered all work, and what was worse, damaged the jetty to quite an extent. The following is extracted from the report of Mr. C. H. Butts, United States overseer, dated September 24, 1885, and is given so that a better understanding of all the circumstances connected with the damage and loss may be known:

> The wind blew fresh from the northeast all day on the 17th, getting up a heavy sea. The following night the wind and sea increased very much, so that on the morning of the 18th the seas were breaking over the jetty from end to end. I went out to the pile-driver, with two men, by using a coil of ratline for a life-line. I went to see if anything more could be done to secure the pile-driver from being thrown off by the waves. At that time the jetty, both pile-drivers, and everything seemed to be able to stand any storm, though the sea was very rough and the wind blowing nearly a gale. All of that day the wind increased, the seas became heavier, and the tide rose; but just before dark I could see the jetty was undisturbed, and the pile-drivers unmoved. All night the wind blew furiously, but its greatest violence was from dark till 2 a. m. of the 19th. During this time the force of the storm was very great; the tide rose to a height of 4.7 feet above mean low tide by the bench-mark on life-saving station.
>
> On the morning of the 19th I discovered that the top course of the jetty was all carried away. The new piles that I had just driven, as well as the old ones, were broken off, and piles, plank, and brush blown ashore.
>
> Before the storm the shore on the south side had built out to Station No. 9 at mean high tide. It was almost as high as the brush-work as far out as Station No. 8, and was covered with dry drifting sand. As far out as Station No. 1 the sand was as high as the top of the plank, or 2 feet higher than the brush-work. I had set the plank down closely to the brush, spiking all anew; had stowed the stone in the best manner possible; but all was of no avail; it was carried away as far back as the bridge I had for drawing over the shore work.
>
> The force of the wind was so great that a schooner with two anchors down in the channel between here and the light-house was driven away down the flats in a southwest direction, between Mustang and Harbor Island.
>
> The wreck Mary, supposed to be down to the clay, was settled 2½ or 3 feet and listed to the north.

The loss in height of jetty appeared to have no detrimental effect upon the bar-channel. A slight change in direction, causing the pilots to move their range a little to the southward, resulted, the deepest channel for navigation being found very close to the jetty immediately after the storm.

As a barrier to the sweeping of vast quantities of sand into the channel from Saint Joseph's Island, a small force was employed, in February, in planting salt cedar—two rows of plants, extending from sand hills to the point of the island. This was in accordance with adopted and approved project, and was done then because of it being the season of the year for planting cedars so as to assure of proper growth.

A recent examination shows that the settlement of the jetty, by compression or undermining, or by action of the teredo, has ceased, and that the foundation is secure and permanent. From the shore-line of mean low tide the seaward portion of the work is entirely submerged, ranging from a depth of 1 foot at in-shore end to 3 feet at a point some 300 feet west of the Mary; the remaining outward extension being in about the same condition as reported last year, viz, submerged 3 to 14 feet, the average being 7 feet, below mean low tide. The revetment and groins protecting the head of Mustang Island have suffered from caving of the bank supporting the work; and the effect of storm-waves, time, and other causes has resulted in their deterioration to such an extent as to require somewhat extensive repairs. The salt cedars planted in February are growing finely, and already are collecting sand. Some shoaling has taken place in the bar channel, the soundings made showing that from a point opposite the Mary, to a point near the outer end of the jetty, but 10 feet of water is available at mean low tide. It is believed, however, that the shoaling is but temporary, having been caused by the very prevalent north and northeast winds of the spring, which invariably have a tendency to shoal this bar.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1887.

Available funds will be applied to the work of rendering secure the head of the island, and continuing work to obtain the necessary concentration desired to scour the bar down to 12 feet, required for navigation.

The work will be in accordance with approved project, and will be in continuance of that heretofore constructed.

During the fiscal year ending June 30, 1888, there could be profitably expended $600,000, in constructing works at the pass and improving the interior channels.

The work is located in the collection district of Corpus Christi, and the nearest light-house is at Aransas Pass.

Money statement.

July 1, 1885, amount available	$6,913 11
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	3,913 21
July 1, 1886, amount available	2,999 90
Amount appropriated by act approved August 5, 1886	101,250 00
Amount available for fiscal year ending June 30, 1887	104,249 90
Amount (estimated) required for completion of existing project	719,472 75
Amount that can be profitably expended in fiscal year ending June 30, 1888	600,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

ROCKPORT, TEX., *July* 14, 1886.

SIR: Your favor of 5th instant, received, and in response we beg to hand you statement of the business of this port, Fulton and Saint Mary's, for the fiscal year ending June, 1886:

Outward shipments:

Cattle	head..	4,565
Merchandise	barrels..	4,120
Fish and turtle	pounds..	308,000

Inward shipments:

Merchandise	barrels..	21,370
Lumber	feet..	712,000
Shingles	feet..	520,000

Very respectfully,

COLEMAN FULTON PASTURE COMPANY,
SAM. J. SEYMORE,
Secretary and Treasurer.

Col. S. M. MANSFIELD.

LETTER OF COLLECTOR OF CUSTOMS AT CORPUS CHRISTI, TEXAS.

CUSTOM-HOUSE, CORPUS CHRISTI, TEX.,
Collector's Office, July 20, 1886.

DEAR SIR: In accordance with your request of the 5th instant, I have the honor to inclose a report of transactions for the fiscal year ending June 30, 1886.

In the matter of entrances and clearances, domestic ports, the report is no criterion to judge of the actual commerce of the port by, as only those vessels having foreign goods report at the custom-house.

Any further information in my power will be cheerfully given.

Very respectfully,

CHARLES F. BAILEY,
Collector.

Col. S. M. MANSFIELD.

ENTRANCES AND CLEARANCES.

Vessels entered from foreign ports	9
Vessels cleared for foreign ports	4
Vessels entered from domestic ports	55
Vessels cleared for domestic ports	51
Value of exports to foreign countries	$134,382 00
Value of imports from foreign countries	1,476,015 00

S 8.

IMPROVEMENT OF HARBOR AT BRAZOS SANTIAGO, TEXAS.

Estimate for jetties and interior dam, 1881	$678,084 59
Appropriated, 1885–'86	*185,000 00
Balance of estimate	493,084 59

ORIGINAL CONDITION OF THE LOCALITY.

The pass which forms the connection between the Laguna Madra and the Gulf of Mexico separates Brazos Island from Padre Island, and the harbor within was obstructed directly across the mouth of the pass by a bar in the usual curved form, situated so as to be entirely exposed to heavy storms, and, being of a quick-sand formation, easily acted upon by tidal currents. The best water (in an ever-shifting channel) across it was about 7 feet. In the harbor the greatest depth was 27 feet.

PROJECT FOR IMPROVEMENT.

To extend two parallel jetties entirely across the bar to the 12-foot curve, the width between the jetties to be about the same as the narrowest part of the pass, viz, 1,500 feet; the south jetty (Brazos Island jetty) to be 3,630 feet long, and the north jetty (Padre Island jetty) to be 2,940 feet; the direction of the jetties to be in prolongation of the pass; the estimated cost of the south jetty about $190,000; estimated cost of the north jetty about $130,000. In addition, to construct a dam from Point Isabel to Brazos Island, to increase the depth of water on the bar and in the channel to Point Isabel, by preventing the flow toward Boca Chico; the estimated cost about $328,000.

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*In addition there was appropriated, in 1878, $6,000, which was applied to removing a wreck.

Approval was given to so much of the project as covered the construction of the south jetty, leaving the question of the north jetty and of the inner dam to the future.

OPERATIONS FROM 1882 TO JUNE 30, 1885.

A south jetty, with a total approximate length of 3,500 feet, was constructed, in the building of which there were used 54,096.74 cubic yards of brush-work and brick ballast.

The amount expended in this work, including superintendence and contingencies, was $184,148.72, and resulted in effecting some improvement in the bar channel, not strictly permanent because of the incomplete condition of the jetty.

No funds were available for operations during the fiscal year 1885-'86, and no work was done.

PROBABLE OPERATIONS OF THE YEAR ENDING JUNE 30, 1887.

For certain reasons the subject of this improvement was referred by letter of December 8, 1885, Office of the Chief of Engineers, to the Board of Engineers, with a view to obtaining the opinion of the Board as to the probable cause of an alleged shoaling on the bar and for suggestion of a remedy. There being no funds sufficient for the purpose of making an examination and survey required by the Board, the Chief of Engineers, under date of February 4, 1886, directed that as soon as funds became available for the purpose a project, with estimate of the cost of the survey, be submitted, so that the necessary steps for its commencement be entered upon without delay.

It is estimated that $4,000 will be necessary to make the examination and survey required. The work of improvement will necessarily await the action of the Board; consequently the operations of the year cannot here be outlined.

During the fiscal year ending June 30, 1888, there could be profitably expended $200,000 (the annual estimate) in continuing work of improvement.

It is located in the collection district of Brownsville, Tex., and the nearest light is Brazos Island light-beacon.

Money statement.

July 1, 1885, amount available	$851 28
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	515 00
July 1, 1886, amount available	336 28
Amount appropriated by act approved August 5, 1886	37,500 00
Amount available for fiscal year ending June 30, 1887	37,836 28
Amount (estimated) required for completion of existing project	455,584 50
Amount that can be profitably expended in fiscal year ending June 30, 1888	200,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, BROWNSVILLE, TEX.,
Collector's Office, July 16, 1886.

DEAR SIR: Yours of July 5 instant duly received and contents noted.

In reply I beg to transmit you the following information regarding entrances clearances of vessels to and from this port:

Foreign entrances	
Foreign clearances	
Coastwise entrances	
Coastwise clearances	

In addition to these there are quite a number of small vessels, such as lumb schooners, &c., coming and going all the time, which are not obliged to file any pers with collector of the port; therefore we have no record of them.

Very respectfully,

J. J. COCKE,
Collector of Custo

S. M. MANSFIELD,
Major of Engineers,
Bvt. Lieut. Col., U. S. A.

S 9.

PROTECTION OF RIVER BANKS AT FORT BROWN, TEXAS.

First appropriation, 1876	$10,000
Second appropriation, 1879	7,000
Third appropriation, 1882	1,000
Total	18,000
Amount expended to June 30, 1886	16,996
Amount available June 30, 1886	1,003

The results attained at this point were not commensurate with the ex penditure; therefore, in 1881, it was considered best not to attempt control the Rio Grande at this place by artificial works, it being thought more expedient to move from time to time such of the buildings should be in actual danger.

No further appropriation is recommended.

Money statement.

July 1, 1885, amount available	$1,003
July 1, 1886, amount available	1,003

APPENDIX T.

IMPROVEMENT OF RED RIVER AND OF CERTAIN RIVERS IN THE STATES OF LOUISIANA, MISSISSIPPI, AND TENNESSEE TRIBUTARY TO THE MISSISSIPPI—WATER-GAUGES ON THE MISSISSIPPI AND ITS PRINCIPAL TRIBUTARIES.

REPORT OF CAPTAIN ERIC BERGLAND, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Red River, Louisiana and Arkansas.
2. Survey of Bayou Pierre, Louisiana.
3. Cypress Bayou, Texas and Louisiana.
4. Cane River, Louisiana.
5. Loggy Bayou, Lake Bisteneau and the Dorcheat, Louisiana.
6. Ouachita and Black rivers, Arkansas and Louisiana.
7. Bayou Bartholomew, Louisiana and Arkansas.
8. Bayou Bœuf, Louisiana.
9. Tensas River and Bayou Macon, Louisiana.
10. Bayou D'Arbonne, Louisiana.
11. Yazoo River, Mississippi.
12. Big Sunflower River, Mississippi.
13. Tchula Lake, Mississippi.
14. Tallahatchee River, Mississippi.
15. Yallabusha River, Mississippi.
16. Steele's Bayou, Mississippi.
17. Big Black River, Mississippi.
18. Big Hatchee River, Tennessee.
19. South Forked Deer River, Tennessee.
20. Water-gauges on the Mississippi River and its principal tributaries.

WILLETS POINT, NEW YORK HARBOR,
July 27, 1886.

SIR: I have the honor to submit herewith annual reports upon the works of river and harbor improvement under my charge during the fiscal year ending June 30, 1886.

Very respectfully, your obedient servant,

ERIC BERGLAND,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

T I.

IMPROVEMENT OF RED RIVER, LOUISIANA AND ARKANSAS.

Red River has its headwaters in Northern Texas and flows in an easterly direction, forming the boundary between Indian Territory and Texas. At Fulton, Ark., it changes its course to a general southeasterly direction, and enters the Mississippi at Red River Landing, La.

Appropriations for the improvement of this river were made at intervals between 1828 and 1841. Between 1841 and 1852 no appropriation was made, and a longer interval of twenty years elapsed between 1852 and 1872, during which time the results of work previously done were lost.

The improvement from 1872 to 1881 was carried on under various appropriations for removing raft in Red River and closing Tone's Bayou, removing obstructions from Red River, and improving Upper Red River from Fulton, Ark., to head of raft. The river and harbor act of August 2, 1882, combined all work on this stream in the general title of improving Red River, which includes the whole river from Fulton, Ark., to the mouth of Atchafalaya River, a distance of about 525 miles.

The present improvement dates from 1872. At that time navigation above Shreveport, La., was almost impossible on account of the great raft. A survey of this obstruction was made in 1871–'72, and estimates submitted for its removal and the subsequent improvement of the river. The work of removing this great obstruction was begun December 1, 1872, and the opening of the channel through the raft was completed November 27, 1873. The work in the raft region since that time has consisted in removing portions of the old raft, leaning timber, and brush from the banks, and breaking jams to prevent blockading of the river and reformation of the raft. This work has been done principally by means of crane, derrick, and snag-boats. In 1879 an examination was made for the purpose of ascertaining the changes in the river since the raft was opened, and it was found that the high-water line had been reduced to a level generally within the banks, a greater depth of water everywhere secured, and an enlarged section of channel-way gained, and that very little water was diverted from the river proper at low stages.

UPPER RIVER FROM FULTON, ARKANSAS, TO SHREVEPORT, LOUISIANA.

By river and harbor acts of 1879 and 1880 appropriations were made for improving the river from Fulton, Ark., to head of raft. An examination of this part of the river was made and report thereon submitted in 1879. At the same time a report was submitted on an examination of the stream above Fulton to the Missouri, Kansas and Texas Railroad Bridge.

Previous to this, in 1875, some leaning timber was cut between the head of raft and a point 24 miles below Fulton. Work was begun in September, 1879, at Fulton and continued down-stream until December. This work was resumed in September, 1880, and continued until high water in December. By the work of these two seasons the river was placed in good navigable condition, when there was sufficient water for boats to run, but as many new obstructions were added by the flood of 1881 the balance of appropriation for this work, with a portion of that for improving Red River, was used in their removal.

During the season of 1882–'83 and 1883–'84 the two snag-boats, Howell and Florence, principally the latter, were employed in removing obstructions from the bed and banks of the river.

During the fiscal year ending June 30, 1885, shore parties removed numerous obstructions from the banks, and the two snag-boats removed formidable raft formations in the old raft region, caused by the flood which occurred early in May.

A dam was built closing the outlet known as the Sale and Murphy Canal. This was completed the latter part of November, 1884. Before it had time to consolidate the December flood came and it was completely destroyed.

No work has been done during the present fiscal year, owing to the small amount of funds available for the improvement of Red River. A portion of the small balance available has been held in reserve to provide for emergencies such as the absolute closure of the river by drift brought down by floods. These usually occur in April or May, but this year has been an exception to the general rule in that the spring floods have not occurred.

The work accomplished up to this time has greatly benefited navigation at all stages. The great raft has been removed and its re-formation prevented, and the river has been kept open to Fulton, to which point boats ascend when there is water enough. During the present fiscal year the channel has become more or less obstructed by snags, bank-slides, and leaning trees, which make navigation tedious and hazardous.

LOWER RIVER, FROM SHREVEPORT, LOUISIANA, TO THE MOUTH.

An examination of Tone's Bayou was made in 1871-'72. The river and harbor act of 1872 appropriated $20,000 for the improvement, the object being to improve the navigation of Red River below Shreveport, it having been seriously affected by the gradual enlargement of Tone's Bayou, the water passing into it depleting the main channel of the river below, causing it to shoal and become narrow without giving another naviagble channel. The project for this improvement, submitted July 16, 1872, recommended closing the bayou with a dam, having its top 10 feet below high-water mark, in order to throw an increased volume into the main river. As the bed of the river enlarged it was proposed to increase the height of the dam by annual appropriations until the bayou should be finally closed. This dam was completed in January, 1873, and destroyed by high water the following March.

In May, 1873, it being found desirable to run drift from the Red River raft out of the navigable channel below Shreveport, the plan of running it into the bayou and closing the latter with a raft was adopted. A boom was therefore constructed and a large raft formed at the site of the dam, but this was also entirely swept away July 8, 1873, going down Tone's Bayou and thence into Bayou Pierre. A second raft was formed later in the season, but the water cut under it and consequently no valuable results were obtained. This also went subsequently with the current into Bayou Pierre.

A plan was submitted in the Annual Report of 1874 to entirely close the bayou with a dam of same height as levees along the river, and the citizens of Shreveport and others interested also urged the total closure of the bayou at that time. The dam was begun in October, 1876, and continued with frequent interruptions from high water until September, 1879, when it was discontinued for lack of funds. At this time the dam had reached a height of 24 feet, or 12 feet below high-water mark, and the top was covered with a heavy layer of stone to weight the mattresses down and prevent drift from damaging the dam. It was found necessary to keep a watchman on the work continuously to see that the dam was not cut, and to prevent the people from carrying away the stone, which is a scarce article in that locality. This dam, although really a low-water dam, was of great benefit to navigation below Shreveport. The water of 1879 reached a point 3½ feet below the low water of 1878, the lowest previously known; but, notwithstanding this, steamboats made regular trips from Shreveport to Grand Ecore, a thi never attempted before the partial closing of the bayou.

It soon became evident that a low-water dam could not be ma tained, hence, in 1880, it was proposed to put in an earthen dam up high-water mark, just above the former, and connect its ends with levees on Red River, and also dam the lower branch of Old River. A contract for this work was entered into in August, 1881, which was to finished during the low-water season of 1881. This the contracto failed to do, and on the night of December 1, 1881, the Confedera dam, built in 1864 across Lower Old River, below the projected da was destroyed, carrying with it the incompleted dam above. Acco ing to affidavits of the agent of the contractors, and several of his m on February 14, 1882, a body of masked men approached the ma dam, took charge of the guards, and cut a ditch across the dam, effect of which caused its destruction. The work being incomplete, h not been accepted by the United States when the dams were destro and consequently no payment was made to the contractors.

In September, 1874, a survey was made of the falls at Alexandr another was made in 1878, and a report thereon submitted Decem 20, 1879, with a project for excavating a channel 75 feet wide, wit permanent depth of 4½ feet below the low water of 1874, through t upper falls, and for building a dam at the lower falls with the rock moved from the channel above. The work of excavation was let contract October 14, 1882, at $3.45 per cubic yard. Owing to lack experience and suitable plant this work progressed slowly, and seve extensions of time were requested and granted.

During the present fiscal year work was resumed August 20, 18 and continued until, by direction of the Chief of Engineers, the co tractor was notified that the contract was closed, November 25, 18 At that date he had excavated 7,630.5 cubic yards of rock, which h been deposited on the dam at the lower falls.

The channel cut through the upper falls is practically comple although the last survey shows that at a few points (principally alo the sides of the cut) the requisite grade had not been attained. Sin work was discontinued many boats have passed through the cut at l stages without experiencing any difficulty or meeting any obstructi The channel has been plainly indicated by means of range marks shore, so that during daylight no difficulty in keeping in the excava channel is experienced.

The rock and débris obtained from the upper falls have been dep ited in the dam at the lower falls. This has sufficed to close the ch nel along the west shore, and has changed the direction of the curre from the west to the east shore. The result has been almost total c sation of erosion of the west bank and the removal of the extens sand-bar which extended along the east bank. The rock excavated the channel at the upper falls, from which the dam has been built, soft and friable, much of which crumbles into small fragments when posed to the air. Hence it was feared that during high water a la portion would be washed away. Such has not been the case; the c binds together the rock fragments, forming a stable concrete which sists the action of the water. In order to secure the diversion of t current from the west shore during high water it may become necess to increase the height of the dam several feet. Rock for this purp can be obtained from a quarry near the east bank, about one mile abo the dam.

The closing of the west chute has caused a very rapid current through the middle channel of the Bailey Dam at low stages. This necessitates the use of lines to enable boats to stem the current, but the dam also benefits the passage over the upper falls by increasing the depth above it. It may be necessary to widen the channel through the Bailey Dam so as to decrease the velocity of the current without increasing the slope too much above the dam.

The project for the protection of the harbor at Alexandria, as described in my last annual report, has been completed as far as the funds available would permit. Work was resumed August 19, 1885, and discontinued December 5, 1885. Amount expended, $14,864.41. The training-wall was made somewhat shorter than projected, because on resumption of work it was found that the site had been scoured out to a greater depth than when the estimates were submitted. Hence only 14 cribs of the training-wall could be built, instead of 18 cribs as given in the original project. This work, in connection with the dam at the lower falls, has been of some benefit to the river-bank at Alexandria. During the fiscal year but little caving of the bank has taken place, and that little has been due to a stratum of quicksand, which causes a sloughing of the bank when the river falls. This sloughing would probably be diminished or arrested if a deposition of sand and sediment occurred along this shore of sufficient depth to cover this stratum of quicksand. To cause such deposition it may be necessary to increase the height of the wing-dam, already built, and to construct one or two additional dams.

The river and harbor acts of 1878 to 1881, inclusive, made appropriations for removing snags and other obstructions from Red River, Louisiana. This work extended from the mouth to Shreveport, and was begun August, 1878, by the snag-boat Wagner, and continued until October, 1881. A shore-party was also employed in 1879 to remove bank obstructions. The snag-boat C. W. Howell was built by contract and received in November, 1881.

During the seasons of 1882–'83 and 1883–'84 the Howell and Florence (principally the former) were employed in removing obstructions below Shreveport. During the latter part of 1882 the United States snag-boat John R. Meigs was temporarily transferred to this river from the Yazoo, to replace the Howell while the latter was undergoing repairs.

During the last fiscal year (1884–'85) the snag-boat Howell and shore-parties removed numerous obstructions to navigation. The snag-boat Florence was sunk at O. K. Bar, raised and towed to Saint Louis, where she was repaired, returning to Shreveport April 15, 1885.

No work has been done for the general improvement of the river during the present fiscal year, as the funds available were insufficient. The property pertaining to this improvement has been stored at Alexandria and Shreveport, and has been well cared for.

The work done heretofore has been of great benefit to navigation; that done by the Howell in 1885 having been eminently satisfactory to those engaged in the navigation of the river. During the present fiscal year many obstructions have formed, which require speedy removal in order to make navigation easy and secure. This is especially the case below Tone's Bayou in the "narrow river," where every effort should be made to assist nature in widening and deepening the water-way.

During the recent low water a bar has formed in the draw of the railroad bridge at Shreveport, preventing boats from passing up or down. A report on this obstruction was submitted to the Department, June 18, 1886.

With the amount asked for the fiscal year ending June 30, 1888, it i proposed to continue the improvement of the river by means of snag- boats and shore-parties below and above Shreveport, to complete the improvement at the falls of Alexandria, and extend the work for the protection of the harbor at Alexandria if authority be granted for said extension. It is considered of great importance that the survey of Re River from Fulton to its mouth be authorized.

The estimate for this survey is $45,000. Without such survey no telligent project for the permanent improvement of this important rive can be submitted.

Appropriations aggregating $535,765.50 were made at intervals b tween 1828 and 1852. The present improvement dates from 1872, an the following amounts have been appropriated:

By act approved June 10, 1872, for improving Tone's Bayou	$20,000
By act approved June 10, 1872, for removing raft	150,000
By act approved March 3, 1873, for removing raft	80,000
By act approved June 23, 1874, for removing raft	50,000
By act approved March 3, 1875, for removing raft	20,000
By act approved August 14, 1876, for removing raft and closing Tone's Bayou	35,000
Allotment August 27, 1877, for closing Tone's Bayou	4,500
By act approved February 7, 1878, for removing raft, &c	6,000
By act approved June 18, 1878, for removing raft and closing Tone's Bayou	24,000
By act approved June 18, 1878, for removing snags and other obstructions	25,000
By act approved March 3, 1879, for removing raft and closing Tone's Bayou	15,000
By act approved March 3, 1879, for removing obstructions	22,500
By act approved March 3, 1879, for improving upper river from Fulton, Ark., to head of raft	10,000
By act approved June 14, 1880, for improving upper river from Fulton, Ark., to head of raft	10,000
By act approved June 14, 1880, for removing raft and closing Tone's Bayou	25,000
By act approved June 14, 1880, for removing obstructions	60,000
By act approved March 3, 1881, for removing obstructions	10,000
By act approved March 3, 1881, for removing raft and closing Tone's Bayou	10,000
By act passed August 2, 1882, for improving Red River	75,000
By act approved July 5, 1884, for improving Red River	75,000
Amount appropriated since 1872	727,000
Amount expended to June 30, 1886	727,000

Money statement.

July 1, 1885, amount available	$12,978
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	11,021
July 1, 1886, amount available	1,950
Amount appropriated by act approved August 5, 1886	75,000
Amount available for fiscal year ending June 30, 1887	76,950
Amount that can be profitably expended in fiscal year ending June 30, 1888	100,000
And, in addition, for survey of Red River, Louisiana and Arkansas	45,000

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

During the fiscal year Upper Red River (above Shreveport, La.) was navigated b four steamboats, drawing from 2¼ to 5½ feet of water, and with carrying capaciti ranging from 100 to 400 tons each. This part of the river was navigable to Kiamati Tex., for two months; to Fulton, Ark., for four months, and to Garland City, Ark the entire year. The boats made a total of 73 trips, or an average of 18 for each boat, and carried the following freights:

Cotton	bales..	11,800
Cotton-seed	sacks..	48,675
Shingles	bundles..	2,400
Miscellaneous freights	tons..	300

Lower Red River (below Shreveport, La.) was navigated by 9 steamboats, drawing from 5 to 9 feet of water, and with carrying capacities ranging from 200 to 800 tons each. Navigation was good between Shreveport and the mouth of the river, except during September, October, and November, 1885, when Grand Ecore was the head of navigation. The boats made a total of 108 trips, or an average of 12 for each boat, and the following freights were carried:

Cotton	bales..	71,686
Cotton-seed	tons..	3,350
Cotton-seed oil	barrels..	3,975
Hides	pounds..	125,000
Wool	do....	100,000
Staves	number..	120,000
Cattle	head..	1,000
Wood	cords..	500
Oil-cake	tons..	550
Oil-cake meal	do....	1,000

Return freights, 21,500 tons general merchandise and plantation supplies; estimated value, $2,500,000.

This has been a season of unusually restricted navigation; and but for this reason it is thought the amount of commerce would have been much greater.

Shreveport, La., having a population of about 12,000 inhabitants, is the main distributing point for Red River.

The following are the commercial statistics of Shreveport for the past year:

Cotton received at Shreveport	bales..	82,500
Cotton-seed received at Shreveport	tons..	5,512
Refined oil shipped from Shreveport	barrels..	3,285
Soap stock shipped from Shreveport	tons..	849
Cotton-lint shipped from Shreveport	do....	110
Cotton-seed meal shipped from Shreveport	sacks..	25,354
Oil-cake shipped from Shreveport	do....	1,525
Ashes shipped from Shreveport	do....	29

Freight shipped to Shreveport, no record.
Freight shipped from Shreveport, no record.

In addition, large quantities of miscellaneous freight, hides, tallow, &c.

T 2.

SURVEY OF BAYOU PIERRE, LOUISIANA.

The Bayou Pierre region is that part of the Red River Valley lying between the river proper and the pine hills on the west, and reaching from a point 2 miles below Shreveport to Grand Ecore, La. It has a southward extent of 60 and a maximum width of 9 miles.

Red River through this region seems to have very nearly its original course, its present banks being the highest part of the bottom. Its principal changes have probably been several local cut-offs within the first 20 miles and near the end of the reach. As far as Tone's Bayou, 18.7 miles by river below Shreveport, it has an average, slightly diminishing, width of about 400 feet and a clear low-water depth of at least 12 feet, except at one point. Below, however, its width suddenly lessens to 150 feet and its depth to 6 feet, the reduction being due to a serious depletion of the stream through Tone's Bayou. This lower river is very tortuous in its course, has a quite uniform channel, and is seriously inadequate for low-water navigation. Its banks are overflowed at the highest stages for about 20 miles below Scopini's cut-off, and thence down-stream the banks rapidly increase in height.

Bayou Pierre, which probably originated as an outlet of the water forced from its banks by the old raft removed in 1835–'39, keeps quite closely along the hills on the west, passes through or rather spreads into Lakes Cunnisnia and Pierre, drains Wallace Lake and the pine hills, and restores its water to Red River through Grand Bayou, Bayou Winsey, and its ultimate mouth at Grand Ecore. The upper part of it, about 16 miles, carries no water at the lower stages, forming only a series of long pools with intervals of mud and dry sand, and being closed just above Tone's Bayou to a height of 9 feet above low water. At high stages, however, it drains through its head, Sand Beach Bayou, and a new break in old Lattier Bend, a considerable volume of water from the river.

Tone's Bayou was originally a drain, cut about 1850, by J. B. Gilmer between Red River and Bayou Pierre. This rapidly increased, and in 1857 was regarded by the State engineers as threatening a total diversion of the main stream. The first effort to close it was made as auxiliary to the opening of Scopini's Cut-off by the Confederate Government in 1863. The dam then constructed, however, was quickly destroyed, and the ultimate effect of the divers military operations thereabout was an increase of the outlet. The closure has subsequently been attempted once by the State and frequently by the United States, but as yet unsuccessfully and without any permanent effect.

The various attempts made by the United States are noted in the report on the improvement of Red River. The only check to the total change of the river course threatened has resulted from the formation of the raft in Bayou Pierre, which at low stages acts as a dam. Tone's Bayou now carries off at low water about one-fourth, and at high water about three-fourths, of the water of the river, and with Bayou Pierre and Bayou Winsey forms the stream which it is proposed to open as a new route for navigation.

The first obstacle to be overcome in realizing this project is the raft in Bayou Pierre, which extends 5.3 miles above and 2.8 miles below Red Bluff, at the mouth of Wallace Lake. The upper portion is fragmentary, of recent formation and loose structure, occupying in the aggregate about one-fifth of the area of water surface. That below is more nearly continuous and gradually becomes denser, until at its lower end it is solidified, turning all the water into a tangle of small streams on the east and Bennett's Bayou on the west, whence the greater part of it is re-collected in the original channel below and thence gradually spread into Lake Cunnisnia. The next notable obstruction is the flat clay bar forming the bottom of the lower half of Lake Cunnisnia.

This is from 15 to 20 feet above a line of uniform slope through the proposed route, the discrepancy being made up in rapids below Lake Pierre. There is a good channel from Le Coup, at the foot of Lake Cunnisnia, for 7½ miles, to Round Lake, a small body of open water in the midst of Lake Pierre, which is otherwise merely a cypress-brake without any distinct channel. At least 2 miles of this would need to be penetrated in the proposed improvement. Just below Lake Pierre there were, at the date of the last examination, rapids, which I am informed are now receding into the lake. Grand or Boggy Bayou, leaving Bayou Pierre 1½ miles below Lake Pierre and reaching Red River within 2½ miles, seems to have become the principal channel of restoration to Red River; its discharge, I am told, having increased remarkably of late. For the next 12 or 15 miles below Grand Bayou, Bayou Pierre has numerous rapids, over bars of hard, insoluble clay; those farthest up-stream being somewhat rocky. Its average width is about 140 feet and its low-water depth between rapids about 15 feet. The snags in this part, according to the report of Mr. Wilson, in 1879, average about 54 to the mile. Below this, for 6 miles through Bayou Winsey to Red River, there is a deep and unobstructed channel.

Mr. Wilson reported that Bayou Pierre for 2 miles below Bayou Winsey was closed to a height of 13¼ feet above low water; that thence there was for 3 miles a good channel; that thence for 16 miles to Spanish Lake the bayou was made almost impassable by snags and cypress knees; and that from Spanish Lake to Red River there was an open channel.

The streams described below carry water only at high stages.

Sand Beach Bayou virtually leaves Red River at Shreve's Cut-off, 6 miles below Shreveport, and enters Bayou Pierre 3 miles above Tone's Bayou. Bayou Chicot leaves Bayou Pierre on the right, 1½ miles below Tone's Bayou, and returns 3 miles lower down, with a small issue between, into Wallace Lake. Pascagoula Bayou traverses the bottom from Red River, 12½ miles below Scopini's Cut-off, to Bayou Pierre, 3 miles above Red Bluff. It is completely closed by two levees crossing. Prairie River, crossing Pascagoula Bayou between these levees, and draining the low lands near Bayou Pierre above, runs between Red River and Lake Cunnisnia, with an issue into Bayou Pierre at Le Coup, and crossing Bayou La Chute near Bayou Pierre, passes parallel with the latter below into Lake Pierre. Bayou La Chute crosses from Red River to Bayou Pierre near the foot of Lake Cunnisnia. At high water it drains both ways, but principally into Bayou Pierre. Cross Bayou and Murrell's Cut are outlets from Lake Pierre to Red River.

The land between Bayou Pierre and Red River is regarded as very fertile. Only the high ground just along the river, however, is cultivated. Probably less than one-fourth of it is available for tillage, the rest being subject to overflow and heavily timbered.

The proper improvement of Red River from Tone's Bayou to Grand Ecore has long been a mooted question. The Government has hitherto undertaken to maintain the river route proper by damming up Tone's Bayou. This has been deemed most advisable by the State engineers of Louisiana, and by the United States Engineer officers in charge of the work. The execution of this project has met with considerable opposition from the planters and others in the vicinity. Those along the front, or on Red River proper, seem to think that the damming of Tone's Bayou would cause the overflow of their lands, while those living on the back channel, or Bayou Peirre, desire to have the latter cleaned out and otherwise improved, and made the main steamboat channel from Tone's Bayou to Bayou Winsey or Grand Ecore. This opposition appears to have become more apparent in late years; for in 1874 Capt William Robinson was deputed by the Shreveport Board of Trade to represent to the Secretary of War the importance of closing Tone's Bayou, and in 1879 citizens of New Orleans and others interested in the navigation of Red River subscribed $3,000 to help repair the dam across the bayou.

The relative advantage of the two routes was discussed at length by Major Howell in Annual Report of Chief of Engineers for 1873, page 628, and by Major Benyaurd in Annual Report for 1882, page 1539.

In the latter part of 1878 an examination was made of Tone's Bayou, Bayou Pierre, and connecting lakes and bayous to Bayou Winsey, in order to ascertain the cost of opening up this route to navigation; this was estimated at $174,404, including the cost of removing the raft in Bayou Pierre, which was estimated at $75,000.

In the spring of 1883 another examination of this region was made, and the estimate for making a navigable channel from the mouth of Bayou Winsey to the entrance of Tone's Bayou, given at $250,125, and for the removal of the raft alone $100,000. The report on this examination recommended an accurate survey of the Bayou Pierre region, at an estimated cost of $8,646. This was based on a detailed estimate submitted to the Department December 29, 1882, in which it was assumed that the field work could be completed in three months.

In order to obtain all the data necessary for a complete discussion of the questions involved, it was considered necessary to include in the survey all the water-ways or bayous lying between Bayou Pierre proper and Red River, from the head of Bayou Pierre to Bayou Winsey, and also Red River between these points. The actual field work of the survey was commenced October 22, 1884, and discontinued January 3, 1885, on account of high water. Mr. Hart Vance, assistant engineer, who has had long experience on the Missouri River and other Government surveys, was placed in charge of the work. During the fiscal year ending June 30, 1885, the following work in the field and office was accomplished:

The survey of Red River from Shreveport, 18¾ miles above Tone's Bayou, to Caspiana Landing, 25.19 miles below, affording an accurate representation of the channel contours and of all adjacent topography; surveys of Bayou Pierre and all bayous between that and Red River from Shreveport to Tone's Bayou; surveys of Tone's Bayou, Bayou Pierre through the raft region, the numerous side issues and small channels into which the water is driven by the raft, and the western part of Lake Cunnisnia to a point about 2 miles above Le Coup; surveys of Pascagoula Bayou and of Prairie River as far as Caspiana Landing; a detached survey of Bayou La Chute and the various channels between Lakes Cunnisnia and Pierre; an examination of Le Coup Bar; divers transit and chain lines for checks, location of levels, &c., along Red River, and between Red River and Bayou Pierre; and observations for discharge in Red River above Tone's Bayou and in Tone's Bayou. The survey included a system of perfectly-checked levels along Red River, Tone's Bayou, and Bayou Pierre, and over three lines between Red River and Bayou Pierre, with frequent observations of water-level and high-water elevations. Gauges were established and read at Shreveport, Cotton Point, Bayou Winsey, and the site of the camp. The survey was mapped on a scale of $\frac{1}{6000}$, making four sheets 10 feet by 42 inches; cross-sections of all of Red River surveyed and of Tone's Bayou and Bayou Pierre to the head of the raft were developed, and comparative profiles of high water, low water, bank and channel-bottom elevations were in process of construction. About one-fourth of the ink-work on these sheets was done.

During the present fiscal year the profiles of high and low water and channel bottom were completed and ink-work upon the large maps was continued from time to time. Between August 22 and September 2, 1885, Assistant Engineer H. Vance went over the track of the survey, examining Bagley's Crevasse, a threatened cut-off from old Lattier Bend to Sand Beach Bayou; supplementing some topographical work which had proved vague; taking high-water and low-stage elevations at Red Bluff and Gravel Point, and connecting with permanent marks the terminal points of the survey submerged in Lake Cunnisnia in December, 1884.

The completion of the survey as projected will involve surveys of Red River, 48 miles; Bayou Pierre, 16 miles; Prairie River, 10 miles; Grand Bayou, 2.5 miles; Cross Bayou, 6 miles; Bayou Winsey, 2.5 miles; possibly several other collateral courses, Lake Pierre, and, practically, half of Lake Cunnisnia.

Several unforeseen circumstances combined to make the cost of the survey exceed the origanal estimate, among which may be mentioned the following: Owing to the lateness of the season, in 1884, when I assumed charge of the work, the organization of the party was so hurried that it was impracticable to obtain in all cases assistants of experience or assured compentency, and consequently some of the early work was valueless, and had to be repeated after reorganizing the party. Failures in the timely delivery of necessary outfit retarded the commencement of the work, after nearly all the expenses of a full party had been assumed. Again, nearly three-fourths of the last month in the field was lost on account of rains, storms, and floods; not more than one full week's work having been done from December 23, 1884, to January 21, 1885.

The interruption of the field work, its suspension owing to high water, and its resumption after a lapse of over 18 months, will necessarily occasion a greater expense than if it had been completed without interruption.

As the survey is incomplete, no estimate can now be submitted of the cost of opening the Bayou Pierre route to navigation. It is, however, of great importance that the survey be completed as contemplated, in order that the question of cost and advisability of opening the Bayou Pierre route may be definitely settled. The cost of completing the surveys to Bayou Winsey is estimated at $5,000.

Money statement.

July 1, 1885, amount available	$663 85
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	525 80
July 1, 1886, amount available	138 05
Amount (estimated) required for completion of existing project	5,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

T 3.

IMPROVEMENT OF CYPRESS BAYOU, TEXAS AND LOUISIANA.

The improvement of Cypress Bayou has included the whole navigable route from Shreveport, La., to Jefferson, Tex., *via* Sodo and Fairy akes and Cypress Bayou. An examination was made by the United States in 1872, and the work of improvement begun the same year and ompleted in 1880; a well-defined channel marked with sign-boards, rom Shreveport to Jefferson, a distance of 65 miles, being the result of he work.

In July, 1884, a steamer was chartered and employed during the month in removing obstructions, such as snags and leaning trees.

In his annual report for 1874 Major Howell submitted a project fo constructing a dam across the lake at Albany Point and making a c through to Red River, at an estimated cost of $372,580, which woul give navigable water from Jefferson to Shreveport nearly all the yea It was recommended that this amount be made available in one appro priation for successful execution of the work. No appropriation ha been made for this project.

By direction of the Chief of Engineers an examination of the baya was made in July, 1883, and report thereon sent to the Departme August 1, 1883, by Major Miller.

The river and harbor act of July 5, 1884, directed a resurvey of th work, to ascertain if the necessary improvement could not be made upo some other plan than that proposed by Major Howell. With the smal balance then available only an examination could be made, and the re port thereon was submitted January 5, 1885. On account of the de creased commerce of the stream—the building of railroads having fu nished more convenient outlets for a large quantity of shipments—an the great cost of the proposed cut and dam across Albany Flats, it wa recommended that the improvement be confined to straightening an marking the present channel, cutting stumps therefrom, and reopenin cuts by dredging, which it is believed will secure safe navigation be tween Jefferson, Tex., and Shreveport, La., for seven or eight month each year. The obstructions to be removed increase in number an magnitude yearly, and it was recommended that the entire amount es mated for ($18,000) be made available in one appropriation for the su cessful prosecution of the work according to the project.

No work was done during the present fiscal year, no money havin been available.

The former appropriations are as follows:

By act approved—	
June 10, 1872	$10,0
March 3, 1873	50,0
August 14, 1876	13,
June 18, 1878	15,0
March 3, 1879	6,
Amoun expended to June 30, 1886	94,0

Money statement.

July 1, 1885, amount available	$31
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	31
Amount appropriated by act approved August 5, 1886	18,000

COMMERCIAL STATISTICS.

During the fiscal year one steamboat of 125 tons burden and drawing 4 feet water navigated Cypress Bayou and the lakes from January to July, making thi trips and carrying the following freights:

Cotton	bales	4,3
Cotton-seed	sacks	16,0

Return freights, 600 tons general merchandise and plantation supplies; estimat value, $40,000.

T 4.

IMPROVEMENT OF CANE RIVER, LOUISIANA.

Cane River is an arm of Red River, about 70 miles in length from its upper end, 2 miles below Grand Ecore, where it leaves Red River, to Colfax, La., where it again joins that stream. It was formerly part of Red River, but in 1849 a cut-off turned the river into its present bed, and Cane River has gradually filled up, until at present it is nearly dry for six months in the year. An examination was made by the United States in December, 1882, and the obstructions to high-water navigation were found to be snags, logs, stumps, caved in and leaning trees, and some rock. No estimate of cost of improvement was submitted by the United States engineer officer in charge, but his assistant estimated the cost of removing the obstructions at $7,665.

The only appropriation for this improvement ($2,500) was made by river and harbor act approved July 5, 1884, and the obstructions were removed during the season of 1884, as far as practicable, with that amount. This work resulted in freeing the channel, to a great extent, of obstructions, increased the depth of water during the navigable season, and enabled steamboats to make quicker trips.

No work was done during the past year for want of funds.

Some obstructions yet remain, the removal of which would lessen the danger of navigation, and some new obstructions are formed yearly, though not to such an extent as on other streams in this locality, as the banks are high, and for about 50 miles are covered with Bermuda grass, and therefore not subject to abrasion; the remaining 20 miles is covered with a heavy growth of timber, and the banks are continually caving and sliding.

This stream being an arm or high-water channel of Red River, it is recommended that appropriations for future improvement be included in those for the main stream, in which case necessary work can be done when and where the interests of navigation require it. No specific amount is therefore asked for the separate improvement of this stream.

Money statement.

July 1, 1885, amount available	$149 69
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	75 00
July 1, 1886, amount available	74 69

COMMERCIAL STATISTICS.

During the fiscal year two small steamboats, drawing 3¼ feet of water and of 100 tons burden each, navigated this stream, making 22 trips, and carrying the following freights:

Cotton	bales	1,000
Cotton-seed	sacks	10,000
Hides	pounds	10,000

The river was navigable during March, April, and May. When the water in Red River is at high stages boats pass entirely through Cane River, but owing to the unusually low water in the main stream during the past year, navigation has been limited both in time and extent, and boats could only ascend Cane River as high as Hertzog's plantation.

T 5.

IMPROVEMENT OF LOGGY BAYOU, LAKE BISTENAU, AND THE DORCHEA BAYOU, LOUISIANA.

Dorcheat Bayou rises in Hempstead County, Arkansas, and flows in southerly direction into Lake Bistenau, which empties through Logg Bayou into Red River, about 110 miles below Shreveport, La.

An examination of the system was made by the United States i December, 1882, when it was found to be obstructed with logs, stump leaning trees, brush, &c., and that it was navigable at high water far up as Murrell's Point, on Dorcheat Bayou, near Minden, La. (abo 70 miles above the mouth of Loggy Bayou), for about five months of th year. No estimate of cost of improvement was submitted by the Unite States Engineer officer in charge, but his assistant, who made the e amination, estimated the cost of removing obstructions, building dam and dredging where necessary, in order to increase the period of nav gation two months, at $19,338.

The only appropriation for this improvement ($5,000) was made river and harbor act approved July 5, 1884, and the most serious o structions to high-water navigation were removed during the season 1884. This work extended over the navigable portion of the lake an bayous, *i. e.*, from Murrell's Point, on the Dorcheat, to the mouth Loggy Bayou, and greatly benefited navigation, increasing the dep of water in many places, and enabling boats to run to the head of nav gation during six months of that fiscal year.

No work was done during the present fiscal year, as the unexpende balance was insufficient to resume operations.

The improvement, like that of all streams in this part of the countr is not permanent, and even if the streams were entirely cleared of o structions during one season, new ones, caused by sliding and cavi banks, would constantly be added, and require removal from time time. To lengthen the navigable season, dredging of bars and narr places would be necessary. It is doubtful whether the demands commerce would justify the great expenditure necessary for such i provement. Minden, which is the principal shipping point, is now co nected by rail with the Vicksburg, Shreveport, and Pacific Railro consequently the importance of the water outlet has greatly diminishe although it is still a convenient evenue for the limited commerce of th country on the east side of Lake Bistenau and Loggy Bayou.

Money statement.

July 1, 1885, amount available	$431
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	340
July 1, 1886, amount available	91

COMMERCIAL STATISTICS.

These streams are usually navigable during high water by boats from Red Riv Owing to the unusually low stages during the past year and the decreased commer on account of the railroad facilities no boats have run during the fiscal year.

T 6.

IMPROVEMENT OF OUACHITA AND BLACK RIVERS, ARKANSAS AND LOUISIANA.

The Ouachita River has its headwaters in Polk County, Arkansas, in the Ouachita Mountains, and, following an irregular course, flows in a general southeasterly direction through Arkansas and Louisiana until, being joined by the Tensas and Little Rivers, at Trinity, La., these form the Black River, which, flowing in a southerly direction, enters the Red River near its mouth. The entire length of the Ouachita is about 500 miles. Black River is 75 miles long.

An examination of Ouachita River from Rockport, Ark., to the Louisiana line was made in 1870, and that portion from Rockport to Arkadelphia, Ark. (45 miles), was found to be little more than a mountain torrent, and was not considered worthy of improvement. A survey of the Ouachita River from Trinity, La., to Camden, Ark., was made in 1871-'72, the report on which recommended the building of five locks, which were to give not less than 4 feet of water in the river at all times, the estimated cost being $1,163,083.75. A resurvey from Camden to Trinity (294 miles) was made in 1873-'74, to determine more definitely certain questionable points connected with the contemplated improvement by locks, and in view of the great cost of the work and its doubtful utility the project was abandoned. The lumber which had been purchased for foundations, at a cost of $20,708.52, was sold at public auction and the proceeds turned into the Treasury. An examination of the river from Arkadelphia to Camden, Ark., was made in December, 1882, and it was recommended that no work be performed between those places.

By river and harbor act of 1884 Black River was added under the same head of appropriation with the Ouachita, this river being the connecting link between Ouachita and Red River, and requiring the same character of improvement. The present project contemplates the removal of obstructions to navigation, consisting of wrecks, logs, snags, leaning timber, &c., and the improvement of shoal places from Camden, Ark., to the mouth of Black River. No estimate of the cost of this improvement can be submitted, as the obstructions are continually forming and require removal from time to time.

Work was begun in 1871, and has been carried on ever since when funds were available, consisting principally in the removal of logs, snags, leaning trees, and similar obstructions to navigation. In 1875 the snag-boat O. G. Wagner was purchased and fitted up, and has operated successfully in the river since that time.

The work heretofore done has greatly benefited navigation by the removal of obstructions, and some of the shoal places have been increased in depth from 12 inches to over 3 feet at low water. Previous to any work of improvement large boats plied between New Orleans and Camden about half the year. These boats now run to Camden from seven to eight months in the year, and smaller boats run to Monroe, La., during the entire year.

During the season of 1884-'85 many formidable obstructions were removed. At that time no work in the river had been done since 1882, and in many places land-slides had occurred, some of them extending entirely across the river and greatly obstructing the channel. These and many other obstructions were removed, the greater portion of the work being between Monroe and the mouth of Black River. The appropriation of July 5, 1884, included the removal of 2 wrecks obstructing th harbor at Monroe, which was accomplished during the fall of 1884.

During the fiscal year no work has been done, the small balan available being necessary for the care and protection of the snag-boa Wagner and other United States property pertaining to this improvement.

A railroad from Vidalia, La., opposite Natchez, Miss., to Trinity, La has been recently completed. This will no doubt form an outlet for a considerable part of the commerce of the Lower Ouachita, Tensas, and Little rivers.

With the amount asked for the fiscal year ending June 30, 1888, it is proposed to continue the improvement of the river as heretofore, i. e building and repairing wing-dams where necessary, removing wreck and bank obstructions by means of shore parties, and channel obstructions by means of the snag-boat O. G. Wagner.

The former appropriations are as follows:

By act approved March 3, 1871	$51,000
By act approved June 10, 1872	100,000
By act approved March 3, 1873	60,000
By act approved August 14, 1876	12,000
By act approved June 18, 1878	10,000
By act approved March 3, 1879	10,000
By act approved June 14, 1880	8,000
By act approved March 3, 1881	12,000
By act passed August 2, 1882	12,000
By act approved July 5, 1884	15,000
Total amount expended to June 30, 1886	289,907

The amount expended on present project, including cost of iron-hull snag-bo and outfit, to June 30, 1886, is $176,320.07.

Money statement.

July 1, 1885, amount available	$1,190
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,098
July 1, 1886, amount available	92
Amount appropriated by act approved August 5, 1886	17,500
Amount available for fiscal year ending June 30, 1887	17,592
Amount that can be profitably expended in fiscal year ending June 30, 1888	22,500

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

During the fiscal year this river was navigable as high as Camden, Ark., for si months, and to Monroe, La., for eight months. Five steamboats, drawing from 6 t 7 feet of water, and with carrying capacities of from 500 to 700 tons each, made total of 68 trips, or an average of nearly 14 for each boat, carrying the following freights:

Cattle	head	2,0
Cotton	bales	53,7
Cotton-seed	sacks	326,0
Hides	pounds	20,0
Wool	do	10,0
Staves	number	125,0
Hogs	head	50
Wood	cords	3,5
Lumber	feet	50,0
Timber	logs	91,0

Return freights 2,200 tons, consisting of general merchandise and plantation supplies; estimated value, $1,805,000.

In addition to the above, the commerce of Bayous Bartholomew, Bœuf, and D'Arbonne, Tensas River, and Bayou Macon, all of which are tributaries, passes up and down the river, some of the boats from these tributaries extending their trips as far as New Orleans.

T 7.

IMPROVEMENT OF BAYOU BARTHOLOMEW, LOUISIANA AND ARKANSAS.

This stream is a tributary of Ouachita River. It rises in Southeastern Arkansas, within a few miles of Pine Bluff, on the Arkansas River, and following an exceedingly tortuous course, flows at first nearly parallel to the Arkansas River, at a distance varying from 15 to 30 miles; then parallel to the Mississippi at about the same average distance, and after entering Louisiana diverges to the southwest and flows into the Ouachita River opposite Ouachita City.

The States of Louisiana and Arkansas have at various times expended funds for surveys and improvements of the bayou. Examinations were made by the United States in 1872, 1879, and 1880. At Baxter, Ark., the Little Rock, Mississippi River and Texas Railroad Bridge crosses the bayou, forming a bar to all navigation above, except for stave boats, of which there are a great many in this part of the stream. An examination of the bayou from Baxter to the Lincoln County line, Arkansas, was made in December, 1884, the report on which (dated January 5, 1885) disapproves the improvement of this portion of the river at present.

The plan of improvement is based upon a report submitted by Major Benyaurd in 1880, estimating the cost of cutting overhanging timber and removing wrecks, snags, &c., obstructing navigation from Baxter, Ark., to the mouth, an estimated distance of 213 miles, at $26,862. The work heretofore done has extended over nearly the entire portion of the bayou included in this project, and has greatly lessened the dangers of navigation, but new obstructions are continually forming, which require removal from time to time in the interest of safe navigation.

No work was done during the fiscal year 1885-'86, no funds being available.

The appropriation asked for the fiscal year ending June 30, 1888, can be profitably expended in cutting leaning timber, removing snags, &c., as heretofore.

The former appropriations are as follows:

By act approved March 3, 1881	$8.000 00
By act passed August 2, 1882	5,000 00
By act approved July 5, 1884	5,000 00
Amount expended to June 30, 1886	17,978 82

Money statement.

July 1, 1885, amount available		$248 68
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$227 50	
July 1, 1886, outstanding liabilities		227 50
July 1, 1886, amount available		21 18
Amount appropriated by act approved August 5, 1886		5,000 00
Amount available for fiscal year ending June 30, 1887		5,021 18
Amount (estimated) required for completion of existing project		3,862 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		4,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

During the fiscal year three steamboats drawing from 3 to 5 feet of water, and w carrying capacities of 100, 300, and 400 tons, made twenty-seven trips in the stre The bayou was navigable for five months, and the following freights were car during these months:

Cotton	bales..	16,
Cotton-seed	sacks..	3,
Staves	number..	56,
Hides	pounds..	5,

Return freights, 1,750 tons, consisting of general merchandise and plantation plies, estimated value $500,000.

T 8.

IMPROVEMENT OF BAYOU BŒUF, LOUISIANA.

Bayou Bœuf rises in Southeastern Arkansas, flows in a southerly rection, and enters the Ouachita River at Stafford's Point, about 10 mi above Harrisonburg, La.

The plan of improvement is based upon an examination made by th United States in 1880. The project contemplates the removal of snag logs, and leaning timber obstructing navigation between Wallace's Lan ing, La., and the mouth of the bayou, a distance of 280 miles, at an e timated cost of $20,000. An examination of the three outlets of Bay Bœuf, near Point Jefferson, La., was made in 1884, and their clo recommended at an estimated cost of $8,500.

The work heretofore done was carried on during 1881, 1882, and 188 The obstructions removed have greatly benefited navigation and lessen the dangers thereof, and boats are enabled to run during high water t Point Jefferson. The improvement is not permanent, as new obstr tions form from time to time which will require removal in the inter of safe navigation. No work was done during the fiscal year, no fun being available.

With the appropriation asked for the fiscal year ending June 30, 18 it is proposed to apply $5,000 to the removal of obstructions from th channel and banks as heretofore, and $8,500 to the closure of the ou lets near Point Jefferson.

The former appropriations are:

By act approved March 3, 1881	$5,00
By act passed August 2, 1882	5,0
By act approved July 5, 1884	5,00
Amount expended to June 30, 1886	14,95

Money statement.

July 1, 1885, amount available	$12
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	12
July 1, 1886, amount available	4
Amount appropriated by act approved August 5, 1886	5,00
Amount available for fiscal year ending June 30, 1887	5,00
Amount (estimated) required for completion of existing project	8,500
Amount that can be profitably expended in fiscal year ending June 30, 1888	8,500

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

During the fiscal year 1 steamboat, drawing 5½ feet, and with a carrying capacity of 300 tons, made 17 trips in the bayou, and 2 tug-boats with barges, drawing 3½ feet, and with carrying capacities of 200 tons each, made 35 trips.

The following freights were carried:

Cotton	bales..	9,370
Cotton-seed	sacks..	18,590
Cattle	head..	125
Staves	number..	60,000
Wood	cords..	427
Hides	pounds..	8,000
Timber	logs..	5,000

Return freights, 3,500 tons, consisting of general merchandise and plantation supplies, estimated value $250,000.

The bayou was navigable as high as Point Jefferson, La., for six months, and to Girard, La., for seven months of the past year.

T 9.

IMPROVEMENT OF TENSAS RIVER AND BAYOU MACON, LOUISIANA.

Tensas River has its source in Northeastern Louisiana, in Lake Providence, flows in a southerly direction, and uniting with the Ouachita and Little rivers, at Trinity, La., the three form Black River. By river and harbor act of July 5, 1884, Bayou Macon was united under the same head of appropriation with Tensas River. This bayou rises in Desha County, Southeastern Arkansas, flows in a southerly direction, entering Tensas River about 40 miles above its mouth.

Examinations of these streams were made in 1880, upon which the present plan of improvement is based. The project contemplates the removal of snags, logs, and leaning timber obstructing navigation in the Tensas, between Dallas and its mouth (about 180 miles), at an estimated cost of $23,000, and the removal of the same class of obstructions in Bayou Macon, from Floyd, the present head of navigation, to its mouth (about 130 miles), at an estimated cost of $17,000.

No work has been done in Bayou Macon, as the funds appropriated were not sufficient to extend operations into that stream.

Tensas River and Bayou Macon are navigable only during high stages of water in Ouachita River. The work heretofore done has benefited navigation in the former by the removal of obstructions from that portion of the stream in which it was carried on. This work, however, is not permanent, as new obstructions are added from time to time which require removal in the interest of safe navigation.

No work has been done since November, 1884, when the funds were exhausted.

With the appropriation asked for the fiscal year ending June 30, 1888, it is proposed to continue the removal of obstructions from the channel and banks as heretofore. If the whole amount estimated for be granted, work can be prosecuted in both streams.

The former appropriations are:

By act approved March 3, 1881	$3,000 00
By act approved July 5, 1884	4,000 00

Money statement.

July 1, 1885, amount available	$15 2
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	15 2
Amount appropriated by act approved August 5, 1886	4,000
Amount (estimated) required for completion of existing project	29,000
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

During the fiscal year these streams were navigable from November to June inclusive. Tensas Bluff, about 95 miles above the mouth, was the head of high-water navigation in Tensas River, from December to June, inclusive; Floyd, about [illegible] miles above the mouth of Bayou Macon, was the head of high-water navigation in that stream, from January to June, inclusive.

Three steamboats, one of 300 and two of 400 tons, drawing from 5 to 6 feet of water loaded, made 21 trips in these streams, and two small steamboats of 50 tons each, drawing from 2¼ to 3¼ feet, loaded, made 38 trips.

The following freights were carried:

Cotton	bales	20,0
Cotton-seed	sacks	60,
Staves	number	10,
Timber	logs	1,000,

Return freights, 5,000 tons, consisting of general merchandise and plantation supplies; estimated value, $835,000.

T 10.

IMPROVEMENT OF BAYOU D'ARBONNE, LOUISIANA.

Bayou D'Arbonne is formed by the junction of the South, Middle, and North or Corney branches, near Farmerville, in Northern Louisiana. It flows in a southeasterly direction, and enters the Ouachita River about [illegible] miles above Monroe, La.

An examination and survey were made in 1883, and the plan of improvement is based upon the latter. The project contemplates the removal of snags, logs, wrecks, leaning trees, &c., obstructing navigation between Stein's Bluff and the mouth, a distance of 42½ miles, at an estimated cost of $15,000.

The only appropriation for the improvement was made by river and harbor act of July 5, 1884, $5,000, and was expended during that season. This bayou, like the other tributaries of Ouachita River, is navigable only during high stages of water in the main stream. The work done has resulted in the removal of obstructions from about one half of that portion of the stream in which improvement is contemplated by the present project. The navigation of this part of the stream has been improved and the dangers lessened by the removal of these obstructions. The work, however, is not permanent, as new obstructions are added from time to time, which require removal in the interest of safe navigation.

No work has been done since December, 1884, when the funds were exhausted.

With the amount asked for the fiscal year ending June 30, 1888, it is proposed to continue the removal of obstructions to navigation according to the project.

Money statement.

July 1, 1885, amount available	$130 59
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	104 66
July 1, 1886, amount available	25 93
Amount appropriated by act approved August 5, 1886	2,000 00
Amount available for fiscal year ending June 30, 1887	2,025 93
Amount (estimated) required for completion of existing project	8,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

During the fiscal year the bayou was navigable from January to May, inclusive, and boats ascended the stream to Stein's Bluff, 42½ miles above the mouth.

Three steamboats, of 100, 200, and 300 tons burden, respectively, and drawing from 3 to 4½ feet of water, made a total of 17 trips in the stream, and the following freights were carried:

Cotton	bales..	8,000
Cotton-seed	sacks..	10,000

Return freights, 600 tons, consisting of general merchandise, and plantation supplies; estimated value, $150,000.

T II.

IMPROVEMENT OF YAZOO RIVER, MISSISSIPPI.

Yazoo River is formed by the junction of Yallabusha and Tallahatchee rivers, in Le Flore County, Mississippi; it is about 264 miles in length, flows in a general southwesterly direction, through one of the richest sections of country in the South, and enters the Mississippi River 9 miles above Vicksburg.

An examination of the wrecks of gunboats, steamers, and other obstructions placed in the river during the late war was made by the United States in 1873, and a similar examination, which included the natural obstructions to navigation, was made in 1874. The project for the improvement contemplated the removal of wrecks, snags, logs, overhanging timber, &c., obstructing navigation throughout the entire length of the stream.

The work, however, cannot be permanent, as new obstructions, caused by floods, caving banks, &c., are brought into the river each year, and require removal to render navigation safe, consequently no detailed estimates for permanent improvement have been submitted.

The wrecks of 11 steamers, sunk during the late war, were removed by contract during 1873-'74. In 1875 and 1877 the United States snagboat O. G. Wagner was employed in removing wrecks and other obstructions. The snag-boat John R. Meigs was completed in October, 1879, and the principal work of improvement since has been carried on with that boat. The results of the work done are marked. The large number of wrecks, and many natural obstructions, which limited the navigable season, have been removed, and the river is navigable throughout the entire year.

No work has been done since operations were suspended January 1, 1885. The small balance available for the present fiscal year was required for the care and preservation of the snag-boat Meigs and other United States property belonging to this improvement.

With the amount asked for the fiscal year ending June 30, 1888, it is proposed to continue the removal of obstructions to navigation by means of shore parties and the snag-boat John R. Meigs, as heretofore.

The former appropriations are:

By act approved March 3, 1873, applied to the removal of eleven wrecks sunk during the late war	$40,000
By act approved March 3, 1875	12,000
By act approved August 14, 1876	15,000
By act approved June 18, 1878	25,000
By act approved March 3, 1879	15,000
By act approved June 14, 1880	12,000
By act approved March 3, 1881	6,000
By act passed August 2, 1882	8,000
By act approved July 5, 1884	10,000
Amount expended to June 30, 1886	142,998

Money statement.

July 1, 1885, amount available	1,246
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,245
July 1, 1886, amount available	1
Amount appropriated by act approved August 5, 1886	15,000
Amount available for fiscal year ending June 30, 1887	15,001
Amount that can be profitably expended in fiscal year ending June 30, 1888	30,000
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

During the past fiscal year 7 steamboats, drawing from 4 to 6 feet of water, and with carrying capacities ranging from 150 to 300 tons, plied in this stream; three of these boats each towed a barge of 200 tons capacity. The river was navigable the entire year, and the boats made one hundred and sixty-eight trips, or an average of twenty-four trips for each boat from Vicksburg to the head of the river.

A small steamer of 32 tons and 3 feet draught of water made 84 trips into the river.

The following freights were carried:

Cotton	bales	76,150	Staves	number	150,000
Cotton-seed	sacks	271,500	Cattle	do	75
Hides	pounds	27,500	Hogs	do	130
Wool	do	2,900	Lumber and timber	feet, B. M.	100,000
Tallow	do	5,000	Wood	cords	500

Return freights of general merchandise and plantation supplies, estimated value, $2,320,000.

In addition to the above, the commerce of Big Sunflower and Tallahatchee rivers and other tributaries, passes up and down this stream.

T 12.

IMPROVEMENT OF BIG SUNFLOWER RIVER, MISSISSIPPI.

This river has its source in Mud Lake, Coahomo County, Mississippi; flows in a southerly direction, and enters the Yazoo River about 55 miles above the mouth of the latter. During extreme high water it is navigable to Clarksdale, Miss., 280 miles above the mouth. Faisonia, 144 miles from the mouth, is ordinarily considered the head of low-water navigation.

An examination was made by the United States in 1878, and the plan adopted for the improvement consisted in building wing-dams, where necessary, to scour a channel of from 3 feet to 40 inches depth, and the removal of snags, sunken logs, and leaning timber obstructing navigation, at an estimated cost of $66,000.

Work was begun in 1879, at which time a boat could not make a trip under ten days, and often fifteen days. After the completion of the work of 1884-'85, it was not a difficult matter to make a trip in six days at the lowest stages. In 1879 there were but 18 or 20 inches of water on the crossings at Oliphant's Bar (eleven in all); during the low-water season of 1884, at no time was there less than 33 inches on the same, and on some of them over 3 feet. The work, however, is not permanent, as, owing to sliding and caving banks and the formation of new bars, obstructions to navigation are added from time to time.

No work has been done since operations were suspended for lack of funds in January, 1885, and numerous additional obstructions have formed since that time.

With the amount asked for the fiscal year ending June 30, 1888, it is proposed to continue the removal of snags, logs, and overhanging trees obstructing navigation, and the construction and repair of wing-dams where required.

The former appropriations are:

By act approved March 3, 1879	$20,000
By act approved June 14, 1880	8,000
By act approved March 3, 1881	4,000
By act passed August 2, 1882	5,000
By act approved July 5, 1884	5,000
Amount expended to June 30, 1886	42,000

Money statement.

July 1, 1885, amount available	$45 38
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	45 38
Amount appropriated by act approved August 5, 1886	5,000 00
Amount (estimated) required for completion of existing project	19,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	15,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

During the fiscal year boats have not gone higher up than William's Landing, about 10 miles above the mouth, to which point the river has been navigable since January , 1886. Johnsonville has been the upper limit of low-water navigation. The river has been navigable the entire year, and two steamboats have plied in the stream; the Headlight, drawing 4½ feet of water, loaded, with a carrying capacity of 195 tons, made 31 trips, and the Evergreen, drawing 3½ feet, loaded, with about half the cap ity of the former, made 49 trips.

The following are the freights carried:

Cotton ....bales..	9,000	Staves.................number..	400,
Cotton-seed ....sacks..	37,000	Cattle ....head..	1,
Hides ....pounds..	7,000	Hogs ....do....	
Wool ....do....	7,000	Lumber and timber.feet, B. M..	5.000,
Tallow ....do....	7,000	Wood ....cords..	1,

Return freights, 2,500 tons, general merchandise and plantation supplies; estim value, $350,000.

T 13.

IMPROVEMENT OF TCHULA LAKE, MISSISSIPPI.

Where the Yazoo River reaches the head of Honey Island, about miles above its mouth, it divides into two branches, the westerly o retaining the name of the river, while the easterly and narrower bran is named Tchula Lake or River. The distance from the head to the f of the island, where the two branches again unite, is about 67 miles.

The country along the lake is highly cultivated, and very producti plantations join one another along its banks. The amount of cotto raised annually is estimated at about 20,000 bales, which formerly w brought to market via the Yazoo River and Tchula Lake, or carried b wagons long distances to the southern division of the Illinois Centr Railroad. During the year this road has begun the construction of a line from Yazoo City to the mouth of the Yallabusha River, whi touches Tchula Lake at several points, and has a tap line from Tch City to the main line at Durant, Miss. It is expected that this new li will be open for traffic next autumn, and it will no doubt transport mo of the cotton which has to be marketed before navigation opens in th lake.

An examination was made by the United States in 1879, and the pro ect based thereon contemplated the removal of snags, logs, overhan ing trees, &c., obstructing navigation, to enable light draught boa to enter the lake earlier in the season. The estimated cost of this im provement was $10,000. Work was begun in 1881 and continued i 1882 and 1884. Navigation has been greatly improved by the remov of overhanging timber, snags, &c., and boats have been enabled to ente the lake earlier and run much later during the season. Much work, however, remains to be done to benefit navigation during medium stages As new obstructions are continually forming, the improvement cann be said to be permanent, and appropriations will be needed from ti to time if the stream is to be kept in a navigable condition.

Nothing has been done since operations were suspended in Februar 1885, for lack of funds.

Should an appropriation be made for the fiscal year ending June 3 1888, it is proposed to continue the removal of bank and channel ob structions as heretofore.

As this stream is really nothing but a branch of the Yazoo River, it i recommended that future appropriations for its improvement be includ in the general appropriation for the Yazoo River.

The former appropriations are:

By act approved March 3, 1881	$3,000
By act passed August 2, 1882	2,500
By act approved July 5, 1884	1,500
Amount expended to June 30, 1886..	6,846

Money statement.

July 1, 1885, amount available	$425 84
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	272 60
July 1, 1886, amount available	153 24
Amount appropriated by act approved August 5, 1886	2,000 00
Amount available for fiscal year ending June 30, 1887	2,153 24
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	5,000 00

COMMERCIAL STATISTICS.

During the fiscal year three steamboats, drawing from 4 to 6 feet, loaded, with carrying capacities of from 200 to 300 tons, navigated this stream from December to June, inclusive, carrying the following freights:

Cotton	bales	13,000
Cotton-seed	sacks	35,000

Return freights of general merchandise and plantation supplies; estimated value $360,000.

T. 14.

IMPROVEMENT OF TALLAHATCHEE RIVER, MISSISSIPPI.

The headwaters of this river are in Tippah and Union counties, in the northern part of Mississippi. It flows in a southwesterly direction until joined by the Coldwater River, in Quitman County; thence, as the main stream, it flows in a southerly direction, and, uniting with the Yallabusha River, in Le Flore County, the two form the Yazoo River.

An examination was made by the United States, and report submitted in January, 1879. The project based thereon contemplated the removal of snags, sunken logs, and overhanging timber obstructing low-water navigation from its junction with the Coldwater to the mouth, a distance of 165 miles, and also the removal of the wreck of the steamer Star of the West, lying in the channel 8 miles above the mouth. The estimated cost of such improvement was $40,000. An additional examination was made in 1880 to obtain further information in regard to the river.

Work was begun in 1879 and continued during 1880, 1881, 1882, and 1884. Part of the appropriations of 1880 and 1881 and the entire appropriation of 1882 ($10,000 in all) were expended above the mouth of Coldwater to Batesville, as required by the appropriation acts. This portion of the river, however, was not included in the original estimate of cost.

The work done has resulted in the removal of a large number of obstructions and greatly increased the capacity of the river for navigation. Previous to improvement the river was navigable from the mouth of Coldwater to the Yazoo about six months of the year. Boats from the Yazoo are now enabled to run to Sharkey's Landing, 100 miles above the mouth, during the entire year, but rarely go above that point at any stage, their owners claiming that the amount of commerce will not justify the expense of a longer trip. Many dangerous obstructions yet remain in the river, the removal of which would greatly benefit navigation.

New obstructions, caused by sliding and caving banks, are also conti ually forming, and no permanent improvement can be effected on th account. It is important, however, to planters and others living alo the banks of the river that it should be kept in good navigable con tion, as it is the only available outlet for their products and return supplies.

No work has been done since operations were suspended and the fun exhausted in December, 1884.

With the amount asked for the fiscal year ending June 30, 1888, it proposed to continue the removal of obstructions from the channel a banks as heretofore. Should the whole amount be appropriated, th work could be carried on in both sections of the river.

The former appropriations are:

By act approved March 3, 1879	$6,
By act approved June 14, 1880	9,
By act approved March 3, 1881	3,
By act passed August 2, 1882	3,
By act approved July 5, 1884	3,
Amount expended to June 30, 1886	$24,
Above mouth of Coldwater	10,
Below mouth of Coldwater	14,

Money statement.

Amount appropriated by act approved August 5, 1886	$3,500
Amount (estimated) required for completion of existing project	22,500
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The river has been navigable to Sharkey's Landing during the entire fiscal ye Seven steamboats from the Yazoo, drawing from 4 to 6 feet, loaded, and with carryi capacities ranging from 150 to 300 tons, pliedin the stream, making one hundred an sixty-eight trips, or an average of twenty-four trips for each boat. Three of the boats each towed a barge of 200 tons capacity.

The following freights were carried:

Cattle	head	[illegible]
Cotton	bales	26,
Cotton-seed	sacks	233,
Hides	pounds	25,
Wool	do	3,
Tallow	do	7,50
Hogs	head	[illegible]
Lumber and timber	feet, B. M	1,900,
Staves	number	418,
Wood	cords	5

Return freights of general merchandise and plantation supplies; estimated valu $750,000.

T 15.

IMPROVEMENT OF YALLABUSHA RIVER, MISSISSIPPI.

The Yallabusha is a small stream, about 90 miles in length. It has its source in Calhoun County, Mississippi, flows through Grenada and Le Flore counties, and unites with the Tallahatchee at a point 3 miles above Greenwood, forming the Yazoo River.

An examination was made in 1879, and the plan of improvement consisted in the removal of snags, sunken logs, leaning timber, &c., obstructing navigation from Grenada, Miss., to the mouth, a distance of 63 miles. An examination of the river above Grenada was made in 1882, and that portion was found to be narrow, shallow, and much obstructed, and was not considered worthy of improvement. The Illinois Central Railroad Bridge and a highway bridge crossing the river at Grenada are barriers to navigation above that point. The original estimate of cost of improvement was $7,000. It was found, however, that additional funds would be required from time to time for the removal of new obstructions, caused by caving banks, &c.

The improvement was begun in 1881, and continued during 1882, 1883, and 1884, and has resulted in making the stream navigable during five or six months of the year, or at high and medium stages of water.

Nothing has been done since December, 1884, when the available funds were exhausted.

Should an appropriation be made for the fiscal year ending June 30, 1888, it is proposed to continue the removal of obstructions from the channel and banks as heretofore.

The former appropriations are:

By act approved March 3, 1881	$3,500
By act passed August 2, 1882	3,500
By act approved July 5, 1884	2,000
Amount expended to June 30, 1886	9,000

COMMERCIAL STATISTICS.

The river was navigable from Grenada to the mouth during about six months of the fiscal year. No steamboats navigated the stream within this time, and no reliable commercial statistics could be obtained.

Money statement.

Amount appropriated by act approved August 5, 1886	$2,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

T 16.

IMPROVEMENT OF STEELE'S BAYOU, MISSISSIPPI.

This bayou is a tributary of Yazoo River. It has its source in Swan Lake, Washington County, Mississippi, flows in a southerly direction parallel to the Mississippi River, and enters the Yazoo about 12 miles above its mouth, and generally it is not navigable except when the Mississippi River is high enough to fill the lower portion of the bayou with its backwater.

An examination was made by the United States in 1880. No estimate of cost of improvement was submitted by the United States Engineer officer in charge, but his assistant, who made the examination, eported the probable cost at $14,960.

The only appropriation for this improvement was made by river and arbor act of July 5, 1884, $2,500.

The work done consisted in the removal of the principal obstructio only. Operations were begun at the foot of Swan Lake and continued down-stream to the mouth. After reaching Murray's Ferry, about miles above the mouth, the stream was at such a high stage that wo had to be confined principally to the removal of leaning trees, whi was continued until the funds were exhausted. This work has bee fited high-water navigation principally. Much remains to be done b fore navigation at medium stages can become practicable and profitab

The upper part of the bayou and the borders of Lake Washingt and Swan Lake furnish the products which are shipped through i The lower portion is subject to overflow from backwater, and not mu land in the vicinity is under cultivation. The west side of Lake Wa ington is not far from the Mississippi River, and a branch of the Lo ville, New Orleans and Texas Railroad extends from Greenville sou to near Issaquena County line, whence it will probably be continued the main line near Rolling Fork. This is located between Swan La and Lake Washington, and will no doubt absorb much of the carryi trade that would otherwise be tributary to Steele's Bayou.

Nothing has been done since operations were suspended in Febru 1885, for the lack of funds.

With the amount asked for the fiscal year ending June 30, 1888, i proposed to continue the removal of obstructions from the channel a banks as heretofore.

Money statement.

July 1, 1885, amount available	$125
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	12
July 1, 1886, amount available	
Amount appropriated by act approved August 5, 1886	2,500
Amount available for the fiscal year ending June 30, 1887	2,56
Amount that can be profitably expended in fiscal year ending June 30, 1888 Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	5,00

COMMERCIAL STATISTICS.

The bayou was navigable from February to May, inclusive, during the past f year. One steamboat, of 200 tons and drawing 3½ feet loaded, towing a barge of tons, drawing 4 feet loaded, made 4 trips into the stream. Another steamboat, of tons and drawing 3½ feet loaded, towing three barges, one of 200 tons and the oth 300 tons each, drawing from 3½ to 5 feet of water, made 9 trips.

The following freights were carried:

Cotton	bales	1
Cotton-seed	sacks	30,
Hides	pounds	
Wool	do	1,
Cattle	head	
Hogs	do	
Lumber and timber	feet, B. M.	3,000,
Wood	cords	1,
Return freights, consisting of general merchandise and plantation supplies, estimated value		150,

T 17.

IMPROVEMENT OF BIG BLACK RIVER, MISSISSIPPI.

This stream rises in Webster and Choctaw counties, Mississippi, flows in a general southwesterly direction, and enters the Mississippi River at Grand Gulf, Miss., having an estimated length of about 400 miles.

The bridge of the Louisville, New Orleans and Texas Railroad, about 15 miles above the mouth, and that of the Vicksburg and Meridian Railway, about 90 miles above the mouth, neither having draws, form obstructions to free and safe navigation at all stages of water. Two highway bridges without draws, respectively, 25 and 78 miles above the mouth, also form barriers to navigation. The river above the first railroad bridge at present is navigated only by flat-boats carrying staves, &c.

Old settlers assert that previous to the building of the railroads, large quantities of cotton and produce were shipped annually down the river in flat and keel boats, and it is probable that if the bridge obstructions were remedied, and the bank and channel obstructions removed, at least a portion of the commerce of the country bordering the river would find a way to market by this route to the Mississippi River. Owing to the comparatively short distances between points on lower Big Black River and the different railroads which border and cross it, as well as its proximity to the Yazoo River at Satartia, it is impossible to form any estimate of the benefits to be derived from the thorough improvement of the river between Cox's Ferry and its mouth.

An examination of the stream was made by the United States in 1881, and the project for its improvement contemplated the removal of snags, logs, overhanging timber, and several wrecks obstructing navigation, from the mouth to Cox's Ferry, a distance of 130 miles, at an estimated cost of $32,000.

The only appropriation for this improvement ($5,000) was made by river and harbor act of July 5, 1884. Operations were begun at the mouth in October, 1884, and continued up stream for a distance of 75¼ miles. This work resulted in the removal of the principal obstructions from the banks and channel, and greatly increased the facilities for navigation on that portion of the river in which it was done.

No work was done during the fiscal year, as the balance available was insufficient to resume operations, if it had been considered advisable to do so.

While the present artificial obstructions remain, the stream will be obstructed at all stages, hence the removal of natural obstructions would only facilitate flat-boat and stave-boat navigation. For these reasons it is thought that for the present no additional funds are required for the improvement of this river.

Money statement.

July 1, 1885, amount available	$879 73
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	621 35
July 1, 1886, amount available	258 38
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,258 38
Amount (estimated) required for completion of existing project	22,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

During the fiscal year six boat-loads of staves, aggregating a total number of abo 200,000, were brought out of this stream. These boats are from 120 to 175 feet lo by 25 feet wide, and have an average draught of water of 7 feet loaded.

A small steamboat, with a carrying capacity of about 150 tons and drawing abo 3 feet of water loaded, made three trips into the lower river during June, lowerin her chimney to pass under the Louisville, New Orleans and Texas Railroad Bridg This boat brought out about 400 sacks of cotton-seed, and carried some return freigh consisting of general merchandise and plantation supplies.

T 18.

IMPROVEMENT OF BIG HATCHEE RIVER, TENNESSEE.

This river has its source in Northeastern Mississippi, flows in a nort westerly and then westerly direction, through the most producti region of West Tennessee, and enters the Mississippi River at the jun tion of Lauderdale and Tipton counties, Tennessee, about 50 miles b river above Memphis.

An examination of the stream was made by the United States i 1879. The project for its improvement contemplates the removal o logs, snags, leaning timber, &c., obstructing navigation from Boliva Tenn., to the mouth, a distance estimated at 240 miles. This wou render the river navigable for light draught boats throughout the yea The estimated cost of this improvement was $30,000.

The improvement of this stream was begun in 1880, and continu during 1881, 1882, and 1884. Before its commencement navigation wa almost impossible. The work done has benefited commerce by allow ing the shipment of products by river, whereas previously the railroa had a monopoly of the carrying trade.

Nothing has been done since the work was suspended, on account o high water, in February, 1885, the balance available being insufficie to resume operations in the stream.

With the amount asked for the fiscal year ending June 30, 1888, it i proposed to continue the removal of channel and bank obstructions a heretofore.

The former appropriations are:

By act approved June 14, 1880	$10,000
By act approved March 3, 1881	3,500
By act passed August 2, 1882	3,000
By act approved July 5, 1884	2,500
Amount expended to June 30, 1886	18,766

Money statement.

July 1, 1885, amount available	$788
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	555
July 1, 1886, amount available	233
Amount appropriated by act approved August 5, 1886	3,000
Amount available for fiscal year ending June 30, 1887	3,233
Amount (estimated) required for completion of existing project	8,000
Amount that can be profitably expended in fiscal year ending June 30, 1888	8,000

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The boats in this stream ply up and down, discharging a large proportion of their freights at the railroad crossing, and making occasional trips to Memphis, hence full commercial statistics could not be obtained. It has been ascertained, however, that the river was navigable for about seven months of the fiscal year. Three steamboats, three tugs, seven barges, and numerous wood-rafts, drawing from 2 to 4 feet of water, navigated it during that time, the steamers having capacities of from 100 to 125 tons each, and the barges 50 tons each.

The following freights were carried:

Cotton	bales..	5,000
Cotton-seed	sacks..	25,000
Staves	number..	1,200,000
Lumber	feet, B. M..	900,000
Wood	cords..	20,000

T 19.

IMPROVEMENT OF SOUTH FORKED DEER RIVER, TENNESSEE.

This river heads in McNairy and Henderson counties, Tennessee, and, flowing in a general northwesterly direction, joins the main Forked Deer River 8 miles below Dyersburg, Tenn. The commerce of the country through which it passes is considerable, and before the introduction of railroads was carried upon this stream to the Mississippi River. Of late years, however, the railroads have diverted the transportation of a large portion of the products in other directions. Two railroads and five county bridges, all without draws; a log boom at Hosier Mill, about 100 miles above the mouth, and a brush dam, 13 miles below Bell's Depot, and about 130 miles above the mouth, which deflects the main body of the river into an artificial channel for the use of private parties, all form serious obstructions to the navigation of this river. Owing to these obstructions, the navigation is principally by means of flat-boats that can pass under the bridges.

An examination of the river was made by the United States in 1880, and the project for its improvement contemplated the removal of snags, logs, leaning timber, and similar obstructions to navigation, at an estimated cost of $19,250. The original plan contemplated improving the river from Sharon to the mouth (about 114 miles), only, but operations have been carried up to Jackson, Tenn., the head of navigation, 81 miles above Sharon.

Work was carried on during 1883 and 1884, and a large number of obstructions, principally overhanging timber, were removed between the mouth and Jackson, which greatly increased the facilities for navigation. As long as the artificial obstructions remain the whole river cannot be made navigable for steamboats, but the portion below the lower obstruction, about 100 miles above the mouth, and the reach from Bell's Depot to Jackson, about 60 miles, can be improved in the interest of steamboat navigation.

Nothing has been done since December, 1884, when the funds for this improvement were exhausted.

Should an appropriation be made for the fiscal year ending June 30, 1888, it is proposed to continue the removal of obstructions from the channel and banks as heretofore.

The former appropriations are:

By act passed August 2, 1882	$3,000
By act approved July 5, 1884	2,000
Amount expended to June 30, 1886	5,000

Money statement.

Amount appropriated by act approved August 5, 1886	$5,000
Amount (estimated) required for completion of existing project	9,2
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

During the fiscal year the stream was navigable from December to June. Its commerce was carried on principally by steamboat, drawing 3 feet of water, and raf The following were brought out of the river:

Staves	number	600,0
Lumber	feet, B. M.	1,900,0
Wood	cords	5,0

T 20.

WATER-GAUGES ON THE MISSISSIPPI RIVER AND ITS PRINCIPAL TRIB TARIES.

By joint resolution of Congress approved February 21, 1871, the Secretary of War was directed "to have water-gauges established and daily observations made of the rise and fall of the Lower Mississippi River and its chief tributaries at or in the vicinity of" certain specified points.

During the fiscal year daily observations have been made at the following stations:

Alexandria, La., on Red River; Baton Rouge, La., on Mississippi River; Cairo, Ill., at junction of Mississippi and Ohio rivers; Carrollton, La., on Mississippi River; Florence, Ala., on Tennessee River; Fort Leavenworth, Kans., on Missouri River; Helena, Ark., on Mississippi River; Jacksonport, Ark., on White River; Lake Providence, La., on Mississippi River; Little Rock, Ark., on Arkansas River; Louisville, Ky. (two, upper and lower), on Ohio River; Memphis, Tenn., on Mississippi River; mouth of White River, Arkansas, on Mississippi River; Nashville, Tenn., on Cumberland River; Natchez, Miss., on Mississippi River; Red River Landing, La., on Mississippi River; Saint Louis, Mo., on Mississippi River; and Vicksburg, Miss., on Mississippi River.

These gauges were established by Maj. William E. Merrill, Corps of Engineers, during the latter part of 1871, except those at Carrollton, La., established January, 1872, and at Nashville, Tenn., August, 1873.

Regular observations were commenced at each station as soon as the gauge was established, and have been continued regularly since, so that a complete record of daily readings at all the stations (with a few exceptions), has been obtained from January, 1872, to the present time. In 1881 bulletin-boards were erected at all stations on the Mississippi for the purpose of giving to steamboats the stage of water each morning.

During the fiscal year the gauges at the following points have been inspected either by myself or under my direction: Memphis, Vicksburg, Carrollton, Louisville, Nashville, Florence, Jacksonport, Little Rock, and Alexandria.

A new gauge was put up at Jacksonport, and the high-water section of the gauge at Nashville was reconstructed and new bench-marks located and marked. In addition to the above the Mississippi River Commission has inspected the gauges on the Mississippi River and made the necessary repairs. Records of the daily readings of the gauges have been furnished the Mississippi River Commission, and a copy of the Carrollton gauge record has been furnished the assistant engineer in local charge of the examination and survey of the South Pass of the Mississippi River. Hydrographs of all gauges were made, but retained in this office.

Copies of the gauge records at all the stations are transmitted herewith.

In accordance with the joint resolution approved February 21, 1871, referred to above, the sum of $5,000 was to be appropriated annually for these gauges. As no appropriation was made for the past fiscal year, and the amount available was not sufficient to maintain all the gauges, the Mississippi River Commission has paid the observers at the gauge stations on the Mississippi River, to prevent the suspension of those important observations.

Money statement.

July 1, 1885, amount available	$2,117 53
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,866 39
July 1, 1886, amount available	251 14
Amount appropriated by act approved August 5, 1886	5,000 00
Amount available for fiscal year ending June 30, 1887	5,251 14
Amount that can be profitably expended in fiscal year ending June 30, 1888	5,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

Comparison of flood of 1886 *with highest water previously recorded at the different stations.*

Stations.	Highest water previously recorded.		Highest water of 1886 to June 30.		Relation to previous highest record.	
	Year.	Gauge reading.	Date.	Gauge reading.	Below.	Above.
		Feet.		*Feet.*	*Feet.*	*Feet.*
Cairo	1883	52.17	April 19	50.98	1.19	....
Memphis	1882	35.15	April 28	34.80	.35	....
Helena	1882	47.20	April 30	48.10	....	.90
Mouth of White River	1882	48.40	May 4	48.30	.10	....
Lake Providence	1862	40.87	May 7	37.91	2.96	....
Vicksburg	1862	51.10	May 7 to 9	44.15	6.95	....
Natchez	1862	50.30	May 9 to 11	43.75	6.55	....
Red River Landing	1883	48.50	May 31	41.94	6.56	....
Baton Rouge	1884	36.20	May 31 to June 2.	32.10	4.10	....
Carrollton	1862	15.90	May 31	13.80	2.10	....
Saint Louis	1844	41.39	May 13	27.00	14.39	....
Louisville (upper)	1884	46.60	April 10	32.75	13.85	....
Louisville (lower)	1884	72.00	April 10	58.45	13.55	....
Fort Leavenworth	1881	26.75	March 26	15.80	10.95	....
Nashville	1882	55.30	April 10	49.50	5.80	....
Florence	1867	31.08	April 8	28.10	2.98	....
acksonport	1867	32.83	May 12	24.00	8.83	....
ittle Rock	1857	31.00	February 16	17.90	13.10	....
Alexandria	1866	36.46	June 17	27.90	8.56	....

APPENDIX U.

IMPROVEMENT OF ARKANSAS RIVER; OF RIVERS IN THE STATE OF ARKANSAS, AND OF BLACK RIVER IN ARKANSAS AND MISSOURI.

REPORT OF CAPTAIN H. S. TABER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1886, *WITH OTHER DOCUMENTS RELATING TO THE WORKS.*

IMPROVEMENTS.

1. Removing obstructions in Arkansas River, Arkansas.
2. Arkansas River at Pine Bluff, Arkansas.
3. Black River, Arkansas and Missouri.
4. White River, Arkansas.
5. White River above Buffalo Shoals, Arkansas.
6. Saint Francis River.
7. Saline River, Arkansas.
8. L'Anguille River, Arkansas.

SURVEYS.

9. Survey of Arkansas River, Arkansas, from Little Rock to its mouth.
10. Continuation of the survey of Arkansas River from Wichita, Kansas, to Fort Gibson, Indian Territory.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., July 1, 1886.

GENERAL: I have the honor to transmit herewith the annual reports for the fiscal year ending June 30, 1886, upon the works under my charge.

I am, general, very respectfully, your obedient servant,

H. S. TABER,
Captain of Engineers.

Brig. Gen. JOHN NEWTON,
Chief of Engineers, U. S. A.

U 1.

REMOVING OBSTRUCTIONS IN ARKANSAS RIVER, ARKANSAS.

As the first expenditure of money on this river was made as early as 1833, it is not an easy matter to determine what was the original condition of the navigable portion of this stream; but from the delta-like upper reaches it may be inferred on very substantial grounds that shifting sand-bars, numerous drift-piles, and dangerous snags characterized the obstacles to navigation in the lower reaches, and gravel and rock shoals, with a few snags and many overhanging trees, constituted those of the upper reaches. The numerous so-called steamboat grave-yards now pointed out by old pilots support this idea.

Such annual reports of the Chief of Engineers as I have, dating from 1873, together with House Ex. Doc. No. 64, Forty-eighth Congress, first session, indicate that, except at a few places, such as Pine Bluff, Ark. and Fort Smith, the general plan of improvement has consisted in snagging operations, which includes cutting overhanging trees and in building wing-dams to improve the shoals, the idea being to afford temporary relief to navigation until complete surveys should render it possible to project a plan for the radical and permanent improvement of the navigable portion of the entire river. For the exceptions noted attention is respectfully invited to reports upon those special cases. The appropriations have been made sometimes for the entire navigable reach and sometimes for certain sections. The grand total of all these appropriations up to June 30, 1886, amounts to $420,376.87. Of this there had been expended to June 30, 1885, $340,214.35, exclusive of certain sums, aggregating over $100,000, that were appropriated with the Mississippi and Missouri rivers, so as not readily to be determined.

The most permanent result of all this expenditure consists in a series of maps made by S. T. Abert from a survey of the river from Fort Gibson, Indian Territory, to Big Rock, Arkansas, 3 miles above Little Rock, Ark., in the year 1870. From the nature of the case the balance of the work has been each year a repetition of that of preceding years.

One iron-hulled snag-boat and one light-draught wooden snag-boat, with all the appliances necessary for snagging operations, were the visible signs of the balance, while the gratitude of those interested in the navigation of the river for a navigation rendered yearly less and less dangerous by the operations of these two boats is the only evidence existing and the only evidence to be expected of work that must be done in a stream like this until by some system of permanent improvement caving banks no longer exist and the annual quota of snags is no longer furnished. Steamboat grave-yards have been rendered a matter of tradition, and yet July 1, 1885, found the entire reach of river from Fort Gibson to its mouth full of snags, despite the effective service of two snag-boats during the season of 1884 and 1885. These snags had been brought by the spring rises, and while not so numerous as usual owing to the care taken to cut trees upon caving banks, yet sufficiently so to seriously interfere with the free navigation of the river.

Only $7,297.21 remained for use during the fiscal year ending June 30, 1886. It was therefore not possible to afford the necessary aid to navigation. At extreme low water in October, 1885, the light-draught boat worked a month upon the worst reaches below Little Rock, aiding navigation at a critical period. It was expected to work the same boat about a month in the reach from Fort Gibson to Little Rock, but her hull was found too rotten to risk further use of the boat with her valuable upper works. As the iron-hulled boat drew too much water for this reach, nothing could be done for it. Indeed the chimneys of the iron boat are too dangerous to warrant using that boat without repairs. Six thousand two hundred and thirty-one dollars and eleven cents were expended, therefore, during the year ending June 30, 1886, for repairs and running expenses of the Wichita and in the care of plant.

The future of the appropriation for this head for the year ending June 30, 1886, has been fraught with very grave consequences to the interests of navigation.

In February, 1885, the river was practically a great free highway of commerce from its mouth to Fort Gibson, and could easily have been ept so at medium stage of water (not the year round, on account of ars) had $36,000 been available. As it is, boats have picked their way rough snags in an uncertain way. One has been sunk, and others amaged, and confidence in river navigation destroyed.

While no permanent results can be secured except by carrying out e details of the plan submitted in my last annual report for the per- anent improvement of the river, yet until that is accomplished there ould be an assured annual appropriation to keep the river free of ıags, in the interests of the constantly increasing commerce, of at least 35,000.

As to commercial statistics, please refer to the head "Survey of the rkansas River from Little Rock to its mouth," in addition to what is iven below.

In two years there has been a most remarkable interest developed in dustries of all kinds, and this State is like a young State in many re- ects.

The people are awake, but as yet do not present facts as to commerce ıat really are to be had, so that all that appears here is much below hat could be given, and which will appear as soon as systematic rec- rds are kept.

Since but $19,875 was appropriated by act approved August 5, 1886, e river will become so obstructed that it will require at least $50,000 maintain a channel during the fiscal year ending June 30, 1888.

The amount ($75,000) appropriated by act approved August 5, 1886, too small to have any appreciable effect in reducing the amount of ıagging operations required during the years ending June 30, 1887, or 388.

Prompt attention to the permanent improvement would save these eavy outlays for snagging, that have to be repeated annually to keep e channel open.

Attention is specially invited to this matter, as there is a great chance ere for practical economy, so far as this river goes.

Money statement.

ıly 1, 1885, amount available		$7,631 21
ıly 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$6,321 11	
ıly 1, 1886, outstanding liabilities	297 00	
		6,618 11
ıly 1, 1886, amount available		1,310 10
mount appropriated by act approved August 5, 1886		19,875 00
mount available for fiscal year ending June 30, 1887		21,185 10
Amount (estimated) required for completion of existing project annually until permanent improvements are effectively begun		35,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888		50,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

KPENSE ACCOUNT, REMOVING OBSTRUCTIONS IN ARKANSAS RIVER, ARKANSAS AND KANSAS.

ay-rolls, labor, &c	$5,594 86
ubsistence supplies	315 15
eneral supplies	177 21
raveling expenses	30 08
tationery	6 14
uel	136 17
ffice rent	60 00
reight charges	1 50
Total	6,321 11

COMMERCIAL STATISTICS.

The commerce referred to here relates principally to the reach between Little Rock and Fort Smith, where, owing to the incomplete state of the maps, no provision has yet been made for anything but snagging operations.

OFFICE OF JENKINS & PARKER,
COTTON-BUYERS AND GENERAL MERCHANTS,
Paris, Ark., July 27, 1886.

DEAR SIR: Our Mr. E. E. Jenkins is out of place just now, and left the information asked for in yours of 21st instant for us to deliver; and our estimate shows, approximately, $150,000 goods sold, 3,246 bales cotton bought, 1,160,000 pounds merchandise received, exclusive of business done by four blacksmith shops, one good flouring and grist mill, three steam cotton-gins.

All our houses except one shipped some cotton by river last season, and, with no river navigation from October 1, 1885, to February 1, 1886, 25 per cent. of the cotton was shipped by boat. About 40 per cent. of the freights received this year (1886) have been by river, and with good navigation the year round 90 per cent. of freights received and shipped by our town would be by boat.

The difference in freights by river and rail is about 20 to 25 cents per hundred in favor of river.

From best showing we can get from other points, asked for, we give about numbers of pounds freights received and bales cotton shipped, and you can pro rata from statement above to arrive at value of business.

Locality.	Freights received.	Cotton shipped.
	Pounds.	*Bales.*
Roseville	800,000	[illegible]
Patterson's Bluff	150,000	[illegible]
Morrison's Bluff	180,000	[illegible]
Prairie View and Ellsworth (inland)	800,000	[illegible]

Charleston does about 20 per cent. less business than our town.

Have been unable to get anything from Magazine and Booneville, both of which may be considered river towns and do a considerable business.

Hoping our efforts may prove of value, and joining you in an earnest wish for better river facilities,

We subscribe ourselves,

JENKINS & PARKER.

Mr. C. T. WALKER.

LETTER OF MR. JAMES K. PERRY.

DARDANELLE, ARK., *July 27, 1886.*

DEAR SIR: In answer to your request for estimate of business at the port of Dardanelle, I have the pleasure to give you the following figures, which may be relied on as a close estimate of the present business, to wit:

Cotton, 16,000 bales, valued at	$720,[illegible]
Dressed lumber, 2,000,000 feet	300,[illegible]
Wool, hides, and furs	10,[illegible]
Wheat and corn	10,[illegible]
Cotton-seed, 1,000 tons	12,[illegible]
Various country produce	5,[illegible]
Cattle, sheep, and horses	20,[illegible]
General merchandise, imported	566,[illegible]

With a river navigable at all seasons of the year the exports of cotton, corn, and cattle may be increased 50 per cent. The shipments of lumber would be increased 100 per cent.

These figures have been arrived at carefully, and may be regarded as reliable.

Yours, truly,

JAMES K. PERRY.

Mr. C. T. WALKER,
Little Rock, Ark.

U 2.

IMPROVEMENT OF ARKANSAS RIVER AT PINE BLUFF, ARKANSAS.

This reach of river, which lies in the vicinity of Pine Bluff, Ark., was in a very bad condition prior to any attempts at improvement. At one point a cut-off was threatened which would change the slope of the river from three-fourths of a foot per mile to 4 feet per mile. At another point a bad bar interfered with navigation at low water, and in the sharp bend in front of the town of Pine Bluff the river was eroding the banks with a rapidity that threatened to sweep the town from existence. The original project proposed to accomplish three objects, viz:

First. To protect the river bank in front of the town from further erosion.

Second. To rectify the course of the river in the bend above town in order to remove a bar now existing there, * * * and also by diminishing the curvature of the bend to lessen the tendency to excessive scour in front of Pine Bluff.

Third. To prevent the formation of a cut-off now threatened across the peninsula opposite Pine Bluff. * * * The whole improvement to extend over 13 miles of river.

Up to June 30, 1884, $67,287.14 had been expended with the above objects in view. Three thousand nine hundred feet of the town front, beginning at Brump's Bayou, was revetted during 1881. Three thousand seven hundred feet of Yell's Bend was revetted the same year to prevent the cut-off, and a wire curtain dike 1,110 feet long was put in to affect the bar. In 1882 3,000 feet more of Yell's Bend was revetted, and in 1883 the old works were repaired, 3,000 feet of bank in Yell's Bend was regraded, and 1,000 feet of high-water protection put in place. During the fiscal year ending June 30, 1884, little was done except to care for plant. July 1, 1884, there remained of all this work only the wire curtain dike. This result was predicted by the various engineers in charge, inasmuch as the works had to be left in an unfinished state owing to failure of funds.

The work in Yell's Bend had, however, a long life to delay the advance of the river until changes above rendered the danger less imminent. The wire curtain dike did good service, and the bar was much improved. The town, however, was left at the mercy of the river.

During the fiscal year ending June 30, 1885, $48,813.98 was expended in building 2 dikes, one 1,520 feet and the other 251 feet in length, as fully set forth in my last annual report. These two dikes successfully arrested the caving banks, and at this writing are in excellent condition and meeting every expectation. During the fiscal year ending June 30, 1886, two short dikes were placed in front of the town to increase the deposit at an expense of $2,150.61. The balance was held as a contingent to watch the ever-changing regimen of the river. The blocks at the lower end of the town are as yet unprotected, and to give absolute security the dikes placed in 1884–'85 should be extended, but it was not deemed wise to expend the balance until a farther contingent fund should be available, inasmuch as it will be some years before the river will have a settled course. Indeed, it cannot have until it is permanently improved upon. Therefore, so long as a change in the regimen above is likely to cause the river to move down upon this peculiar reach and attack the banks in an entirely new quarter, so long will it be necessary to have a contingent with which to guard the works. Just now the cut-off tendency is at a minimum. How long it will remain a cannot be stated.

Following the tenor of my report of last year, I have to say that wit the contingent fund made available by act approved August 5, 1886, the river will be cared for as may be necessary to preserve the works, and the recommendation that a yearly contingent of $8,000 be provided for the present is renewed.

This seems a very slight amount, in view of the vast interests at stake, but it is perfectly adequade in the hands of any engineer who understands the nature of large alluvial streams. It must however be steadily provided, or hundreds of thousands will represent the money needed to repair damages. The universal verdict at Pine Bluff is now that the Arkansas River is under control. The annual contingent of $8,0 cannot be regarded as needed for experiment, but simply to erect structures, that time has shown are capable of absolutely controlling the river in this its very worst reach, when all interests are considered. In this connection my report for last year should be carefully read. The importance of the interests at stake in this reach would warrant an epitome of the principal statements embodied in that report. As these are all, however, now a matter of printed record, such an epitome would be superfluous. It should be distinctly remembered, however, that no serious study should be made of this reach without a careful examination of the report referred to, as the recommendations contained in this report are based almost entirely upon facts and figures found in that one.

Money statement.

July 1, 1885, amount available		$7,53
Received by sale of fuel to officer		12
		7,54
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$4,619 80	
July 1, 1886, outstanding liabilities	465 00	
		5,08
July 1, 1886, amount available		2,46
Amount appropriated by act approved August 5, 1886		8,00
Amount available for fiscal year ending June 30, 1887		10,46
Amount (estimated) required for completion of existing project, annually until river is permanently improved above		8,00
Amount that can be profitably expended in fiscal year ending June 30, 1888		8,00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

EXPENSE ACCOUNT, IMPROVING ARKANSAS RIVER, AT PINE BLUFF, ARKANSAS.

Pay-roll, labor, &c	$3,88
General supplies	431
Traveling expenses	157
Telegraph service	3
Fuel	161
Stationery	10
Freight charges	1
Rent	30
	4,6

U 3.

IMPROVEMENT OF BLACK RIVER, ARKANSAS AND MISSOURI.

Before any improvements were made upon this river, its channel was hoked with logs and snags, and obstructed by overhanging trees, and n many places shoals interfered with its navigation at low water by any ut very light-draught boats.

Its banks caved but little, and, except at the shoals, it was characterzed by greater depth of water than is found in streams generally in the icinity, due to its being narrow and its banks firm.

The original plan for its improvement contemplated the removal of he obstructions and the improvement of the shoals, the latter by wing-lams. A few sloughs were to be closed up so as to confine the water o the main channel.

Up to June 30, 1885, $49,610.80 had been expended in carrying out the bove plan. This expenditure gave great relief to navigation, especially hat made in the year ending June 30, 1885, inasmuch as the new snagoat operated in that year.

It is to be regretted that no appropriation was made available for he year ending June 30, 1886, as some of the good effects of the work he previous year were lost, owing to there not being funds to open up he upper river. Nothing has been done during the fiscal year ending une 30, 1886, the funds sufficing only to preserve the property. Snagging operations in this stream, as in others of similar character in this istrict, have to be repeated annually, though not so much so in this paricular river as in some others, on account of the more permanent charcter of its banks.

There are a few shoals that should be improved by wing-dams and posibly a few chutes that need closing. Taking all these facts together, t is estimated that $10,000 could be profitably expended during the fiscal ear ending June 30, 1888. It is believed that after this river is thorughly opened up, a sum not to exceed $8,000 a year will keep it open o navigation, until the country becomes cleared up, when a less sum ould suffice, on account of the smaller number of snags likely to be rought in annually.

Since by act approved August 5, 1886, only $5,000 were appropriated, 15,000 could be profitably expended in the year ending June 30, 1888.

Money statement.

uly 1, 1885, amount available		$1,624 10
uly 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$1,121 32	
uly 1, 1886, outstanding liabilities	145 00	
		1,266 32
uly 1, 1886, amount available		502 78
mount appropriated by act approved August 5, 1886		5,000 00
mount available for fiscal year ending June 30, 1887		5,502 78

Amount (estimated) required for completion of existing project, an annual appropriation of	8,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	15,000 00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

EXPENSE ACCOUNT IMPROVING BLACK RIVER, ARKANSAS AND MISSOURI.

Pay-roll, labor, &c	$1,005 33
General supplies	3 45
Traveling expenses	35 90
Fuel	10 50
Rent of office	60 00
Stationery	6 14
Total	1,121 32

COMMERCIAL STATISTICS.

STEAMER GEORGE W. DECKER,
Newport, Ark., June 4, 1886.

Replying to your favor of 2d instant relative to amount of business done per year, will say that Black and Current rivers carry out about 15,000 bales of cotton, 800 tons cotton seed, 40,000 bushels corn, 5,000 bushels wheat, about $20,000 worth of hogs and bacon, and 700,000 pounds general store merchandise.

The milling interests are large; fully 3,000,000 staves and 20,000,000 feet lumber are handled per year.

At least one-third of the above estimate is brought out of Current River, which is deep, but being narrow is obstructed by overhanging trees and snags, and requires attention the same as Black River.

Will also state that about 300,000 railroad ties are handled above Black Rock.

Respectfully, yours,

GEORGE GOODRICH.

H. S. TABER,
Captain, U. S. Corps of Engineers.

U 4.

IMPROVEMENT OF WHITE RIVER, ARKANSAS.

This appropriation was made by act approved July 5, 1884, and is the first separate appropriation made for the entire river, if the small one of $10,000, made by act approved March 3, 1879, is excepted. Earliest appropriations made for this river, under any head, was made by act approved March 2, 1833. Summing up all the various works of improvement, it may be inferred that prior to 1833 this river was much choked with drift piles, logs, and snags in its lower portions, and, say from Batesville up, gravel shoals, rocky crossings, channel bowlders, and overhanging trees impeded navigation.

In the originally-adopted project snagging operations figured largely. To these were added blasting operations for ledges and bowlders, and dam building, to remove gravel bars, to close chutes, from time to time, as appropriations warranted and commerce required. This river has been united so often with the Saint Francis, and again once with the Black and Saint Francis, and once with the Black and Little Red, that, having no records in this office earlier than the first Annual Report of the Chief of Engineers, received after the entry of the officer in charge into the service in 1873, it is impossible to give exactly how much had been expended on the White River to June 30, 1884.

After a careful study of House Ex. Doc. No. 64, Forty-eighth Congress, first session, the approximate amount is set down as not under $170,000, and not over $200,000. This estimate should be given a weight: 8 in a scale of 10. On July 1, 1864, the river was in excellent navigable condition for boats drawing not to exceed 3 feet of water from its mouth to Newport, Ark. From Newport to Batesville there were many troublesome snags, and from Batesville to Buffalo Shoals there were numerous bad shoals, rendering navigation very uncertain.

From Buffalo Shoals to Forsythe, Mo., there were many fine reaches of river; but the depth of water on Buffalo Shoals and others less dangerous prevented any navigation at ordinary stages of water.

The first project proper under this separate head was forwarded to your office August 18, 1884, and recived back approved August 25, 1884, and, briefly stated, provides that the $35,000 appropriated be "employed in the general work of improving the White River, removing snags and bowlders and other obstructions to navigation, building wing-dams to improve shoals, repairs to plant and care of same," and "to survey the river, as provided for by my predecessor, accurately, with a view to its improvement from Forsythe, Mo., to as far down as possible, at an expense not to exceed $80 per mile," a fixed sum of $11,366 to be set aside for the survey. The survey was begun early in May, 1885. Except when the interests of navigation required immediate improvements, it was deemed best to do as little work as possible until the survey gave a better idea of where the money could be applied to best advantage.

The principal expenditures for improvements made during the fiscal year ending June 30, 1885, were made for that portion of the river lying between Jacksonport and Buffalo Shoals. There was an unexpended balance of the appropriation for the "improvement of the White River between Jacksonport and Buffalo Shoals," available July 1, 1884. When this was exhausted, work was continued for a short time under this head.

The survey was pushed forward with much vigor during July and August, and had reached Newport, Ark., when the amount allotted for it was exhausted. This includes a pencil plotting of the notes upon rough paper, to give a general idea of where the present funds could be expended to the best advantage. Some $400, or more, will be required to complete the notes.

It was thought best to extend the field work as far as possible, and trust to personal work in the way of plotting the notes, in order that a better idea might be had of the river at once. A very complete survey was thus made of 248 miles of river at a cost of about $45 per mile. By a careful selection of energetic civil engineers as assistants, nearly double the amount of river contemplated in the appropriation was covered by the survey, and the work further described in the way of improvement has been in every way more thorough than would have been possible without the notes, though no time has been found to plot them sufficiently to draw any plan for the permanent improvement of the river.

Indeed it is doubtful if it were wise to draw such plan until the survey shall have been completed to the mouth of the river, when the entire river may be studied as a whole; $13,634 is required to complete the original project for the survey, and as this is a very worthy river, bordered by a fertile and rapidly developing country, this survey should be completed without delay.

The urgency of the matter is also more apparent when the condition of the plant and the presence of the numbers of the old force is considered.

If this work is to be done at all it can be most economically done at once.

Shortly after the survey had covered the reach from Calico Rock to Newport a party was put into the field, with all appliances necessary for removing bowlders and building dams.

Beginning at Calico Rock, at a season when extreme low water was found, thorough work was made, providing a narrow channel for boats drawing not over 24 inches of water down to Batesville, or until the channel has this depth naturally. As far as possible this work was in keeping with the plan for the permanent improvement which it has been possible to forecast in a general way.

Without making this report too long no adequate idea can be given of the economical work that could be done by waiting for extreme low water. At first there was a complaint that a large sum of money had been appropriated, and there was too much delay in expending it, but when the work was actually done, and the boats began to run over the long reach of improved river, no further complaint was heard, but rather many words of congratulation and satisfaction were used in the way of atoning for former action and expression.

The intention was to complete this work through to Buffalo Shoals, but the water became so low that the outfit could not get higher than Calico Rock.

It accordingly worked as above, and shortly after it reached Batesville, where the party was disbanded, cold weather came on, precluding further work.

With a view to saving expense for steam-power, watch was kept on the river, and the outfit transferred at trifling expense, at high water, to Buffalo Shoals.

It was not until late in June, 1886, that the water subsided enough to get at work; at the present writing even more economical work is being done than below Calico Rock.

The dams at Buffalo Shoals have all been repaired, and the outfit is dropping down the river, testing its work as it goes, as it must have the low-water channel required (2 feet) before it can drop down. The party is made up of the very best men of the district, its economical and thorough work is a practical demonstration of what could be done if appropriations were made continuous until the work of improving any given river was completed. Of course, the funds at hand only warrant the opening of a very narrow channel, but as far as possible the work done is so planned as to be in keeping with the plans of permanent improvement which will eventually be drawn.

To remove snags in the lower reaches of the river, and to repair the dams and maintain the channel to and above Buffalo Shoals until plans for the permanent improvement can be drawn, will require an annual expenditure of from $8,000 to $10,000. This amount is accordingly recommended, with the reservation that should there be available the sum necessary to complete the survey during the year ending June 3[illegible] 1887, and there be time to prepare plans and estimates for the permanent improvement of the river in time for the action of the next Congress, then, as appears above, this recommendation shall not be considered.

Money statement.

July 1, 1885, amount available		$26,5[illegible]
Received by sale of fuel to officer		15[illegible]
		26,6[illegible]
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$18,670 79	
July 1, 1886, outstanding liabilities	276 43	
		18,9[illegible]
July 1, 1886, amount available		7,6[illegible]
Amount appropriated by act approved August 5, 1886		18,0[illegible]
Amount available for fiscal year ending June 30, 1887		25,6[illegible]

Amount (estimated) annually required to maintain present channel	$10,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1888	10,000 00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

EXPENSE ACCOUNT FOR IMPROVING WHITE RIVER, ARKANSAS.

Pay-roll, labor, &c	$14,885 08
Subsistence supplies........	2,361 27
General supplies	384 88
Fuel	284 72
Traveling expenses	441 27
Transportation	162 59
Telegraph service	7 14
Office rent	90 00
Stationery	53 84
	18,670 79

COMMERCIAL STATISTICS.

STEAMER JOHN F. ALLEN,
Batesville, June 30, 1886.

DEAR SIR: * * * I submit the following as the amount of business done by steamer John F. Allen on the Upper White River, from September 17, 1885, to June 30, 1886: Delivered at Newport and Batesville, 5,063 bales cotton and 13,277 sacks cotton seed. Up freights, 740 tons general merchandise and 1,200 barrels salt.

Very respectfully,

CHAS. B. WOODBURY.

Capt. H. S. TABER,
Corps of Engineers.

BATESVILLE, ARK, *July* 16, 1886.

FREIGHT CARRIED BY STEAMER HOME SINCE JANUARY 1, 1886, UNTIL MAY 30, 1886.

	Tons.
Cotton brought out........	645
Other freight brought out	15
Freight taken up........	339
Total	999

T. B. STALLINGS.

U 5.

IMPROVEMENT OF WHITE RIVER ABOVE BUFFALO SHOALS, ARKANSAS.

Before any work was ever done on this particular reach the channel at low water was much choked by logs. In many places large bowlders rendered navigation dangerous or impossible, and in numerous places gravel and rock shoals existed, which held the water in pools. In short, it was a stream to which lock and dam or movable dams could only be applied with any permanent success. The first appropriation was one of $50,000 (act approved June 23, 1874), and this applied not only to this reach, but all the way from Jacksonport. This money was expended in removing logs and the most dangerous bowlders and in improving the shoals by wing-dams, but appears to have been more largely expended below this reach, as per Major Suter's report. By an act approved August 14, 1876, $10,000 was appropriated for Buffalo Shoals.

The first separate appropriation under this head was under act approved June 14, 1880, and in amount $20,000, and it was estimated that the total cost of the improvement would be $101,220, and this amount was to be largely used in improving shoal places. The next was under act approved August 2, 1882, and in amount $4,000.

To July 1, 1885, $23,181.63 had been expended on direct appropriations. How much of the others went to this reach cannot be determined from the records. This expenditure has relieved navigation very much, but was too small in amount to cover only a few miles immediately above Buffalo Shoals.

During the year ending June 30, 1886, the small balance ($818.[illegible] was expended in repairing the dams at Buffalo Shoals. This was thus used in the most economical manner possible, as it was applied in connection with funds from the general appropriation improving the White River. As stated in my last annual report, it was husbanded for this purpose.

To save repetition, all matter relating to work done on Buffalo Shoals is placed under the general head "Improving the White River, Ark." The money statement is, however, added here to avoid confusion.

It may be noted in finishing this, the last report upon this old appropriation, that there are few places where more lasting benefits have been conferred upon the interests of commerce than in the work done upon Buffalo Shoals, under past appropriations.

Money statement.

July 1, 1885, amount available	$818 [illegible]
Received by sale of fuel to officer	6 [illegible]
	824 [illegible]
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	824 [illegible]

EXPENSE ACCOUNT, IMPROVING WHITE RIVER ABOVE BUFFALO SHOALS, ARKANSAS.

Pay-rolls, labor, &c	$521 [illegible]
Subsistence supplies	216 [illegible]
General supplies	7 [illegible]
Stationery	6 [illegible]
Freight charges	7 [illegible]
Fuel	19 [illegible]
Traveling expenses	16 [illegible]
Office rent	30 [illegible]
	824 [illegible]

U 6.

IMPROVEMENT OF SAINT FRANCIS RIVER, ARKANSAS.

This appropriation was made by act approved July 5, 1884, and is the first separate appropriation made for the entire river. Earliest appropriation made for this river under any head was made by act approved March 2, 1833. Summing up all the various works of improvement, it may be inferred that prior to 1833 this river was much choked with drift-piles, logs, and snags, and its waters spread out through a great variety of sloughs, while overhanging trees added to the difficulties of navigation. In the originally adopted project snagging operations figured largely, and attempts have been made to close up some of the many sloughs.

This river has been united so often with the White River and also with the Black River that it is impossible to give exactly how much had been expended upon the Saint Francis River to June 30, 1884. After a careful study of House Ex. Doc. No. 64, Forty-eighth Congress, first session, the approximate amount is set down as not under $70,000 or over $100,000. This estimate should be given 8 in a scale of 10. During the fiscal year ending June 30, 1885, $8,394.68 was expended on this river.

On July 1, 1884, the river was in an excellent navigable condition from its mouth as high as Wittsburg at medium stage of water. During high water boats have been as high as Lester's Landing. From Lester's Landing to Saint Francis the river was very badly choked with drift and divided into many channels, thus cutting off a rapidly developing section from all facilities of transportation.

The first project proper under this head was forwarded to the office of the Chief of Engineers October 21, 1884, and, briefly stated, provides that the $12,000 appropriated be expended in building a strongly-built decked scow, drawing from 10 to 12 inches of water, supplied with suitable appliances for removing obstructions, with accommodations for the working party, and that this boat be run about five months wherever its services were most needed by the interests of navigation, the scow to cost not over $4,000, and her running expenses not to exceed $1,500 per month.

The outfit as outlined above was completed in time to work about forty days in the fiscal year ending June 30, 1885. During the fiscal year ending June 30, 1886, $4,479.05 was expended in the repairs and running expenses of this snag-boat.

As stated in my last annual report, much pains was taken to build a powerful boat, and her success has been in keeping with this thought. She has during the season accomplished results that were pronounced impossible and gone where no boat has ever ventured during low water, opening up a hitherto impassable reach of river, and giving the citizens along the banks a confidence in the ultimate opening of the river by the Government most gratifying to witness. In the midst of her greatest triumph the funds were exhausted, but not until an open, though very narrow channel, had been provided to Saint Francis. All this has settled the question of her adaptability, and it is only a question of time and appropriations when this worthy river can be made a useful artery of trade. It will require about $8,000 per year for several years to accomplish this.

There is no river in the State that is more worthy of improvement in the interests of navigation. The more study I have given the stream and the country the more interesting the study becomes, and the more convincing the arguments in favor of opening up the river. With no transportation except a wagon, a fertile section rapidly settling up between Lester's Landing and Saint Francis would at once pour out through this channel its products, adding many times the sum required for the improvements to the material prosperity of the country.

Whatever decision may be rendered as to the desirability of further expenditure, the river now has a plant of its own peculiarly adapted to its work, and can be cared for at a very small outlay. It would be better to put the river in excellent shape before the plant deteriorates, and it is believed that after a few years of thorough work the river will maintain itself. As to future demands, the development of the country can alone decide what these will be.

It may be that dredging the sunk lands to bring the river back to its own channel may be warranted in years to come and that low-water navigation may be demanded. At present the prospect is too remote to devote time to plans and estimates for these improvements.

I regret to note that an attempt has been made to toll a part of the river opened up by this boat. While there is a practical proof of the effectiveness of the work in the impetus given to trade, it is hoped that wiser counsels will prevail before it becomes necessary to use the strong arm of the law to maintain the improved channel as a free river.

No correspondence, nor any oral matter, ever passed between this office and the company demanding toll in which they ever claimed any special jurisdiction over any portion of the channel.

The funds being limited, the boat was ordered to open up the channel that bid fair to be of greatest permanence and that could at some time be made immediately available at the minimum cost. This she did impartially, and by so doing has made a free channel wherever she went.

Attention is specially invited to the commercial statistics which are appended. They indicate an amount of commerce shown by few rivers of its size.

Since the body of the report was written I have learned that prior to the work in the upper reach, *i. e.*, just in advance of the snag-boat, a steamer tried to make a trip from Kennett, Mo., to Saint Francis, Ark. She carried no freight, and with a crew of twelve men succeeded in getting through in eleven working days. Immediately after the snag-boat had worked over the reach the same boat made two trips a week with a crew of three men carrying her regular freight.

Money statement.

July 1, 1885, amount available	$4,537
Received by sale of fuel to officer	6
	4,543
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	4,479
July 1, 1886, amount available	64
Amount appropriated by act approved August 5, 1886	8,000
Amount available for fiscal year ending June 30, 1887	8,064
Amount (estimated) required for completion of existing project, annually, until the country is developed to warrant permanent improvement	8,000
Amount that can be profitably expended in fiscal year ending June 30, 1888	8,000
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

EXPENSE ACCOUNT FOR IMPROVING SAINT FRANCIS RIVER, ARKANSAS.

Pay-roll, labor, &c	$3,309
Subsistence supplies	814
General supplies	173
Fuel	40
Freight and express charges	26
Telegraph service	[illegible]
Stationery	40
Traveling expenses	73
	4,479

COMMERCIAL STATISTICS.

KENNETT, MO., *July* 5, 1886.

SIR: We, the undersigned citizens of Missouri, have the honor to state that, after careful investigation, we find the commerce of this section that will be benefited by the improvement of the Saint Francis River, between Lester's Landing and Saint Francis alone, may be determined by the following facts, based on actual figures obtained from each precinct in the county, and in localities seeking an outlet per river:

Fifteen acres cotton and 10,000 acres corn planted annually.

Seven thousand bales cotton, 25,000 bushels corn, and 3,500 tons cotton-seed produced annually; will be largely increased this year.

Five hundred tons merchandise, 600,000 staves, and 700,000 feet lumber shipped in last twelve months; both lumber and staves increasing.

Very truly, yours,

FULLER BALLARD.

Signed by:

W. F. SHELTON, merchant, Kennett, Mo.; T. E. BALDWIN, judge of probate and county treasurer, Kennett, Mo.; E. J. LANGDON, president of the county court, Kennett, Mo.; W. G. BRAGG, jr., clerk of the circuit court; D. P. PANKEY, clerk of county court; J. F. DONALDSON, sheriff and collector; J. D. THOMAS, director Transportation Company; C. A. PETTY, director Transportation Company; N. J. MCBRIDE, associate judge county court; JAMES M. DOUGLASS, justice of county court; ELI T. ANDERSON, physician and surgeon, Hornersville, Mo.; W. S. VAN DIVER, planter; JAMES B. HAYDEN, planter; S. L. PHILLIPS, merchant, Kennett, Mo.; S. S. WHITE, merchant, Kennett, Mo.; S. A. SAGE, justice peace, Kennett, Mo.; R. M. FINNEY, attorney, Kennett, Mo.; T. N. MCHANEY, notary public; A. B. MOBLEY, president Dunklin County Transportation Company.

H. S. TABER,
Captain, United States Corps of Engineers.

LETTER OF MR. Z. T. PURCELL.

GREENWAY, CLAY COUNTY, ARKANSAS, *June* 3, 1886.

SIR: Your letter of May 24 came duly to hand. I can only give you the approximate commerce of the Saint Francis, or the adjacent county of Saint Francis from the county line of Mississippi County, Arkansas, up to the crossing of the F. and St. L. Railway. The commerce is principally moved by wagons, but would go by river if it had the obstructions removed and those sloughs closed, as I wrote you last year, which could be done for four or five thousand dollars if intelligently and honestly applied.

The annexed figures are about the actual amount at present, and would be greater if there was any certainty of the transportation; especially the staves and lumber would be five times greater.

Since receiving your letter I have made inquiry and received the opinion of some of the best-posted men in this district, and the figures I give is the average; the value s price at railroad:

Lumber	$3,150,000
Staves	225,000
Cotton (10,000 bales)	450,000
Corn (600,000 bushels)	300,000
Pork	300,000
Potatoes (300,000 bushels)	100,000
Miscellaneous	300,000

It is stated at Saint Francis station that the commerce above the railroad is equal, if ot greater. There is a little steamboat that runs from the railroad about 60 miles up. I have no other facts concerning the river above at present.

Hoping this is satisfactory, I am, yours, &c.,

Z. T. PURCELL.

H. S. TABER,
Captain, United States Engineers.

LETTER OF MR. D. B. PANKEY.

THE DUNKLIN COUNTY TRANSPORTATION COMPANY,
Kennett, Mo., May 31, 1886.

DEAR SIR: In reply to yours of 24th instant, I would beg leave to make the following statistics of the commerce upon the Saint Francis River between the towns of Kennett, Mo., and Saint Francis, Ark., viz:

Acres of cotton annually	15,[illegible]
Acres of corn annually	10,[illegible]
Bales of cotton annually	7,[illegible]
Bushels of corn annually	25,[illegible]
Tons of cotton-seed annually	3,[illegible]
Tons of merchandise annually shipped to this portion of the county	[illegible]

Six hundred thousand staves shipped last twelve months, and that branch of business rapidly on the increase.

Seven hundred thousand feet of lumber will be shipped from July 1, 1885, to July 1, 1886, and this business is increasing more than any other branch of business here.

For further information I would refer you to William M. Satterfield, of Caruth, Mo., and James M. Douglass, Senath, Mo.

Hoping the above will be satisfactory,

I am, very respectfully,

D. B. PANKEY,
Secretary Dunklin County Transportation Company.

H. S. TABER,
Captain United States Corps Engineers.

LETTER OF CAPTAIN O. K. JOPLIN.

MEMPHIS, TENN., *July* 12, 1886.

SIR: In reply to yours of 5th instant, Saint Francis River usually shipped to New Orleans and Memphis 25,000 bales of cotton, 250,000 sacks of cotton-seed, and about 175 tons of merchandise per week.

Very respectfully,

O. K. JOPLIN,
Captain.

H. S. TABER,
Captain, United States Corps of Engineers.

LETTER OF MR. G. W. KIGER, AGENT.

SAINT FRANCIS, ARK, *June* 12, 1886.

DEAR SIR: Yours of the 10th instant received and duly noted. In reply would say:

The commerce of this section of the Saint Francis River is composed chiefly of lumber, staves, and cotton, and so far has proved to be an important business, and only shows what it could be advanced to if the river was only improved, so that navigation would not be impeded by fallen timber and one or two sand-bars that can be easily remedied.

The number of cars of lumber and staves shipped from this station for the past three years, coming off the river, will average 500 car loads per year.

From 8,000 to 12,000 bales of cotton would be moved this way, besides thousands of bushels of corn that is raised yearly in the vicinity of Kennett and points below, that finds no market, on account of the extreme cost and present disadvantages that producers have to contend with at present.

There will be several mills and stave factories located down on the Saint Francis River in the next six years, that expect to bring their products this way if the river is properly opened, which can be done with a very reasonable appropriation.

It would have a tendency to open thousands of acres of the finest farming lands in this section of the two States, Missouri and Arkansas.

* * * * * * *

The country is here to back the, business, and all that is necessary is a chance to show what it can be increased to.

Yours, truly,

G. W. KIGER, *Agent.*

Capt. H. S. TABER,
United States Corps of Engineers.

LETTER OF MR. W. A. MAY.

SUNK LANDS, *June* 23, 1886.

DEAR SIR: Your favor of the 24th ultimo was received some time ago. You request me to furnish you prior to July 1 "as complete statistics of the commerce upon the Saint Francis River as I may be able to secure," &c.

I will state here that owing to the present condition of said river, much of the produce of the country is hauled to the railroads, thereby depriving, to a great extent, the steamboats of an immense amount of freight.

If work should be properly done on Saint Francis Lake and River, such as deepening, straightening, and removing stumps and logs, so as to enable boats to run the entire year, except perhaps the months of June, July, and August, the freight that goes out in other ways would be carried out by the boats, thus giving shippers easier and better facilities for removing their products, and at the same time add from one-third to one-half to the commerce upon the Saint Francis.

You will bear in mind that this is one of the best timbered sections in the Southwest, and that each year vast quantities of walnut, cypress, gum, &c., are floated and boated out of said lake and river, aggregating in value at least a quarter of a million of dollars. Remember, this is only from the (now) head of navigation down.

The head of navigation now is Lester's Landing, in Craighead County, Arkansas.

You cannot scarcely imagine the amount, much less compute the value of the additional timber and other products that would be boated or floated out, if the Saint Francis should be made navigable from said Lester's Landing up to the Saint Francis crossing of the Narrow Gauge Railroad in Missouri.

In addition to this, large quantities of various kinds of staves are being carried out when the water will admit.

G. M. Rosengranz, of Paragould, Greene County, Arkansas, had from two to four steamboats running from Lester's Landing to Mark-Tree during most of the last fall and winter, carrying out staves, but this work is suspended now on account of the low stage of the water. This alone was high up into the thousands.

Many others would engage in similar enterprises if facilities for getting to market were better.

Besides all this, we must take into account at least 5,000 bales of cotton that are produced by the farmers in this section; also, the thousands of bushels of corn and the many other products, such as potatoes, onions, cabbage, &c., which the rich land produces in abundance.

As above stated, much of the cotton—from one-third to one-half—goes to the railroads.

But little corn is shipped, and the reason of this is that the boats cannot run until it is almost winter, and 12 to 20 miles is too far to haul a wagon-load of corn of only 15 or 20 bushels.

Up to now I would say that each year the commerce on Saint Francis Lake and River has been as follows, as nearly as can be approximated, viz: Timber of all kinds, $250,000; staves of all kinds, $150,000; cotton, corn, and other products, $250,000.

This will be below rather than above the aggregate amount of commerce on the Saint Francis Lake and River, from Lester's Landing to Mark-Tree, for any one year during the past five.

While it is slowly increasing, it would almost double itself in one year, in my judgment, if the river and lake were improved so as to enable parties engaged in getting out timber, staves, and other products to enjoy better and easier facilities.

I remain yours, very respectfully,

WILL A. MAY.

Capt. H. S. TABER,
United States Corps of Engineers.

P. S.—By permission I refer you to Rev. William Y. M. Wilkinson, Arnold Stotts, James Stotts, and G. M. Rims for information on this subject.

W. A. MAY.

U 7.

IMPROVEMENT OF SALINE RIVER, ARKANSAS.

Before improvement, this river was obstructed by snags, logs, driftpiles, and overhanging trees, and by shoals. The original plan for improvement contemplated the rendering of its channel navigable as high as practicable, or as commerce demanded, by the removal of these obstructions, and then further improvement of the shoals if the commerce warranted.

There was expended upon this river up to June 30, 1885, $29,951.7 This has given much relief to navigation, and has practically cleared the river so far as present navigation demands.

During the fiscal year ending June 30, 1886, $404.56 has been expended in caring for the property.

Until the requirements of commerce are greater than they are now, it is not recommended than any further appropriation be made.

From $5,000 to $6,000 per year would keep this river in a fair navigable condition during medium stages of water for 250 miles from its mouth; that is, up to Big Island, should it be required.

Money statement.

July 1, 1885, amount available		$5[illegible]
Received by sale of fuel to officers		4 [illegible]
		522 [illegible]
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$404 56	
July 1, 1886, outstanding liabilities	10 00	
		414 [illegible]
July 1, 1886, amount available		15[illegible]
Amount available for fiscal year ending June 30, 1887		15[illegible]

EXPENSE ACCOUNT, IMPROVING SALINE RIVER, ARKANSAS.

Pay-roll, labor, &c	$303 [illegible]
Traveling expenses	25 [illegible]
Stationery	26 [illegible]
Fuel	19 [illegible]
Office rent	30 [illegible]
	404 [illegible]

U 8.

IMPROVEMENT OF L'ANGUILLE RIVER, ARKANSAS.

This river, like all the streams in eastern and southeastern portions of Arkansas, before being improved was obstructed by logs, snags, and overhanging trees and the shoals incident to the accumulation of snags and logs.

The original plan of improvement, begun in 1879, contemplated the removal of these obstacles, and up to June 30, 1885, $13,850.53 had been expended in such a manner as to remove all obstacles to navigation at medium stages of water, leaving a balance of $3,149.47.

To properly improve this channel for low-water navigation requires a peculiar outfit with very light-draught, and yet with machinery capable of lifting water-logged saw-logs and light snags. Prior to January, 1885, this district owned no outfit adapted to this kind of work. Between January and May, 1885, such an outfit was built for the Saint Francis River, and as no interests of navigation would suffer thereby, or at least would suffer but little compared with the results to be secured by waiting, it was decided to wait until the funds for improving the Saint Francis River had been exhaused, and then, under proper authority, transfer this outfit to the L'Anguille River. This was done

There were many interruptions, due to high water, rendering it necessary to discharge the force from time to time, so that the work was not completed.

Two thousand four hundred and seven dollars and eighty cents was expended during the fiscal year ending June 30, 1886. It is expected that by July 15, 1886, the river will have fallen to extreme low water. Two months' work will then be put in and to an advantage hitherto unknown, and it is expected that this will so thoroughly clear the channel from all obstructions that no work will need to be done in many years. As the river now is, its water is so low for 3 miles from Marianna down at extreme low water that boats cannot ascend at this time higher than a point 3 miles below town.

The time may come in the development of this country when the amount of commerce will warrant the erection of a lock and dam that will enable boats to run to Marianna the year round.

At present the amount of commerce will scarcely warrant the outlay.

No further appropriations are recommended at present.

Money statement.

July 1, 1885, amount available		$3,149 47
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	$2,407 80	
July 1, 1886, outstanding liabilities	56 15	
		2,463 95
July 1, 1886, amount available		741 67

EXPENSE ACCOUNT, IMPROVING L'ANGUILLE RIVER, ARKANSAS.

Pay-rolls, labor, &c	$1,696 17
Subsistence supplies	417 34
General supplies	194 74
Traveling expenses	74 37
Fuel	22 00
Express and freight charges	70
Telegraph service	2 48
Total	2,407 80

U 9.

SURVEY OF ARKANSAS RIVER, ARKANSAS, FROM LITTLE ROCK TO ITS MOUTH.

The original plan for this survey contemplated covering the river with a series of triangles, determining the shore-line both at high and low water, the position of the bars and islands, the general topography of the valley to the bluffs when these are not too far from the river, the depth of the water, the gauging of the river at various points and principal tributaries, the nature of the soil and character of the river-bed, cross-sections to be made at frequent intervals, the slope to be accurately determined, and all other attainable data to be collected that will bear upon the problem of the permanent improvement of the navigation of the river.

There had been expended upon this project to June 30, 1885, $17,361.79, which had completed the field work practically and placed the maps in an advanced stage of completion, During the fiscal year ending June 30, 1886, $1,627.01 has been expended in completing the maps.

The last clause in the summary in my last annual report cannot be understood in this connection unless the reader is careful to bear in mind that it refers to the entire river, though appearing under the head of a survey from Little Rock to the mouth, as there are funds called for there apparently, from the grammatical construction, to complete work under this special head, when really there were funds in hand for this purpose.

Money statement.

July 1, 1885, amount available	$1,930 [illegible]
Received by sale of fuel to officer	4 [illegible]
	1,935 [illegible]
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	1,627 [illegible]
July 1, 1886, amount available	308 [illegible]

EXPENSE ACCOUNT, SURVEY OF ARKANSAS RIVER, ARKANSAS.

Pay-rolls, labor, &c	$1,425 [illegible]
Subsistence supplies	24 [illegible]
Travel expenses	15 [illegible]
Stationery supplies	27 [illegible]
Instruments	56 [illegible]
Fuel	17 [illegible]
Rent	60 [illegible]
Total	1,627 [illegible]

COMMERCIAL STATISTICS.

In reply to a letter sent to the Little Rock Board of Trade the following letter was received:

LITTLE ROCK BOARD OF TRADE,
Little Rock, Ark., July 27, 1886.

DEAR SIR: In reply to your request for information as to the region to be benefited by the proposed Arkansas River improvements, we desire to say that there are no official data whence to draw statistical information except that of the United States census of 1880.

The region to be benefited by the improvements embraces the richest lands west of the Mississippi River, "the center of maximum cotton production per acre in natural soils in the United States, and probably in the world."

Twenty of the most populous and productive counties of the State of Arkansas are directly interested in this measure of river improvements. In 1880 these counties had a population of 256,664, and produced 212,273 bales of cotton, and 7,000,000 bushels of grain, corn, oats, rye, wheat, &c.

The State increased in population during the last decade 65 per cent., in area of tillable lands 84.5 per cent., and doubled her crop of cotton; so that in 1880 Arkansas stood fifth in total production and three in yield per acre among the cotton-producing States. The per cent. of increase has been maintained during the past six years, especially along the Arkansas River.

The commercial growth and prosperity of Fort Smith, Little Rock, and Pine Bluff, the three largest cities in the valley of the Arkansas, demonstrate that to-day over 300,000 industrious and deserving citizens are closely concerned in the improvement of the Arkansas River and the securing of the needful appropriations from Congress to carry out the plans you have made for widening and deepening the channel of the river.

Over 200,000 tons will have its cost of transportation cheapened (the railway running parallel to the river in 1880 carried 111,735 tons) by the improvement of the channel to secure an all-the-year-round water-way.

As to the lumber and forest products, the coal and other articles which should have cheap transportation, a channel such as you propose will benefit a large and growing class of industries and a prospective commerce of very large proportions.

Enough has been said to place beyond doubt the need for the improvements, and we, as a committee of the board of trade, wish to urge the importance to the region in which they are to be made.

Expressing our high appreciation of your intelligent and patient work in this great work for our State, we remain,

Very truly, yours,

JOHN D. ADAMS,
C. T. WALKER,
C. H. WHITTEMORE,
T. H. JONES,
W. E. TOBEY,
Committee Board of Trade.

Capt. H. S. TABER,
United States Engineers.

Appended to the above letter was the following exhibit of the river trade of the city of Little Rock, which was prepared by one of the leading wholesale merchants of the city:

Articles.	Received and handled.	Value.	Amount of business with river.
	Tons.		
Groceries	32,600	$3,900,000	$555,000
Dry goods	8,000	1,190,000	195,000
Hides and tallow	8,772	400,000	105,000
Lumber, shingles, &c	10,000	375,000	105,000
Machinery	12,000	4,000,000	150,000
Drugs, &c	800	300,000	60,000
Hardware, nails, &c	9,000	850,000	125,000
Boots, shoes, and clothing	600	200,000	10,000
Coal and fuel	80,000	240,000	25,000
Furniture	600	120,000	10,000
Grain, flour, &c	24,000	4,350,000	285,000
Bone and rags, iron, &c	150	25,000	10,000

Respectfully submitted, as the best I could do with time and information at hand.

C. H. WHITTEMORE,
Merchant.

Banking business of Little Rock, $150,000,000 per year

U 10.

CONTINUATION OF THE SURVEY OF ARKANSAS RIVER, FROM WICHITA, KANSAS, TO FORT GIBSON, INDIAN TERRITORY.

Provided for in the river and harbor act of August 2, 1882. There was expended to June 30, 1885, upon this $9,120.87, which completed the field work in an indifferent way, and plotted the notes after a very rough fashion.

During the fiscal year ending June 30, 1886, the balance of the allotment, $179.13, was expended in putting the maps in a little better shape, and in preparing a rough tracing to forward with the plans and estimates for this reach of river. This still leaves the maps in a very unsatisfactory condition.

A report was prepared and submitted January 23, 1886, which was printed as House Ex. Doc. No. 90, Forty-ninth Congress, first session, with full plans and estimates for the improvement of the river from Arkansas City, Kans., to Fort Gibson, Ind. T.

Money statement.

July 1, 1885, amount available	$179 [illegible]
July 1, 1886, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1885	179 [illegible]

Amount (estimated) required for completion of existing project	1,696,900 [illegible]
Amount that can be profitably expended in fiscal year ending June 30, 1888	250,000 [illegible]

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

For commercial statistics, see the executive document referred to in the body of the report.

EXPENSE ACCOUNT FOR THE CONTINUATION OF THE SURVEY OF ARKANSAS RIVER FROM WICHITA, KANSAS, TO FORT GIBSON, INDIAN TERRITORY.

Pay-rolls, labor, &c	$172 [illegible]
Fuel	5 [illegible]
Telegraph service	[illegible]
Stationery	[illegible]
	179 [illegible]

INDEX.

Subject.	Page. Part I.	Page. Part II.	Page. Part III.
A.			
Advisory Harbor Commission at Philadelphia	123	849	
Ahnapee Harbor, Wis., improvement of	297		1662
Alabama River, improvement of	201	1171	
Allegheny River, Pa., improvement of	273		1544
Allegheny River, lock and dam at Herr's Island	273		1545
Alpena Harbor, Mich., improvement of	321		1825
Altamaha River, Ga., improvement of	186	1105	
Amite River, La., improvement of	213	1239	
Annapolis Harbor, Md., improvement of	134	877	
Ann, Cape, Mass., construction of harbor of refuge at Rockport	67 580		
Apalachicola Bay, Fla., improvement of	193	1140	
Apalachicola River, Fla., improvement of	196	1153	
Appomattox River, Va., improvement of	150	958	
Aqueduct bridge across Potomac at Georgetown, examination of	148	931	
Aransas Pass and Bay, Tex., improvement of	226	1330	
Archer's Hope River, Va., improvement of	152	962	
Arkansas River, from Fort Gibson to Wichita, survey of	244	1391	
Arkansas River, from Little Rock to its mouth, survey of	244	1389	
Arkansas River, at Pine Bluff, improvement of	238	1375	
Arkansas River, operations of snag-boats on	238	1371	
Ashland Harbor, Wis., in Ashland Bay, Lake Superior, examination and survey of	301		1674
Ashley River, S. C., improvement of	179	1080	
Ashtabula Harbor, Ohio, improvement of	337		1871
Au Sable Harbor, Mich., improvement of	321		1825
B.			
Baltimore, defenses of	28		
Baltimore Harbor, improvement of entrance to	133	874	
Bangor Harbor, Me., improvement of	55 530		
Battalion of Engineers	53 489		
Bay of Superior, Wis., improvement of	288		1639
Bayou Bartholomew, La. and Ark., improvement of	231	1353	
Bayou Black, La., improvement of	217	1261	
Bayou Bœuf, La., improvement of	231	1354	
Bayou Courtableau, La., improvement of	218	1263	
Bayou D'Arbonne, La., improvement of	232	1356	
Bayou La Fourche, La., improvement of	219	1266	
Bayou Macon, La., improvement of	232	1355	
Bayou Pierre, La., survey of	229	1343	
Bayou Teche, connecting with Grand Lake	216	1259	
Bayou Teche, La., improvement of	215	1245	
Bayou Terrebonne, La., improvement of	219	1264	
Beaufort, N. C., to New Berne, inland navigation between, improvement of	163	963	
Beaufort, N. C., defenses of	33		
Beaufort Harbor, N. C., improvement of	164	986	

Subject.	Page.			
	Part I.		Part II.	Part III.
Belfast Harbor, Me., improvement of	56	535		15
Belle River, Mich., ice harbor at	324			
Big Black River, Miss., improvement of	236		1365	
Big Hatchie River, Tenn., improvement of	236		1366	
Big Sandy River, W. Va. and Ky., improvement of	284			1618
Big Sunflower River, Miss., improvement of	234		1359	
Biloxi, Miss., improvement of harbor at	209		1205	
Black Lake Harbor, Mich., improvement of	314			176
Black River, Ark. and La., improvement of	230		1351	
Black River, Ark. and Mo., improvement of	240		1377	
Black River Harbor, Ohio, improvement of	333			186
Black Rock Harbor, Conn., improvement of	87	646		
Black Warrior River, Ala., improvement of	208		1199	
Blackwater River, Va., improvement of	152		961	
Block Island, R. I., construction of harbor of refuge at	77	609		
Board of Engineers, special, on fortifications, &c		499		
Board of Engineers for Fortifications and for River and Harbor Improvements	48			
Bœuf River, La., improvement of	231		1354	
Boston, Mass., defenses of	12			
Boston Harbor, Mass., improvement of	63	564		
Brazos River, Tex., improvement of mouth of	225		1327	
Brazos Santiago, Tex., improvement of harbor at	226		1334	
Breton Bay, Md., improvement of	140		901	
Bridge, Aqueduct, at Georgetown, D. C., examination of	148		931	
Bridge, new, across Potomac River at Washington, D. C., plans for			892	
Bridge across Alabama River at Selma, Ala	370			213
Bridge across Mississippi River at Keithsburg, Ill	369			2111
Bridge across Mississippi River at Minneapolis, Minn	369			2111
Bridge across Ohio River at Cairo, Ill	369			2116
Bridge across Ohio River at Henderson, Ky	370			213
Bridging navigable waters of the United States	369			2111
Bridgeport Harbor, Conn., improvement of	86	644		
Broad Creek, Del., improvement of	128		863	
Broadkiln River, Del., improvement of	128		862	
Brown, Fort, Tex., protection of river bank at	227		1336	
Brunswick Harbor, Ga., improvement of	187		1112	
Buckhannon River, W. Va., improvement of	286			169
Buffalo Bayou, Tex., improvement of	225		1325	
Buffalo Harbor, N. Y., improvement of	340			186
Burlington Harbor, Vt., improvement of	349			196
Buttermilk Channel, New York Harbor, improvement of	97	720		
C.				
Cahaba River, Ala., improvement of	202		1173	
Calcasieu River and Pass, La., improvement of	220		1276	
Caloosahatchee River, Fla., improvement of	196		1152	
Calumet Harbor, Ill., improvement of	307			17
Calumet River, improvement of	308			17
Canal at the Cascades, Columbia River, Oreg., construction of	358			19
Canal at Des Moines Rapids, Mississippi River	253		1465	
Canal, Hennepin, additional surveys for	309			17
Canal, Louisville and Portland, operating and maintaining	277			15
Canal, Muscle Shoals, Tennessee River, construction of	265			15
Canal, Saint Clair Flats, Mich	324			18
Canal, Saint Mary's Falls, Mich	319			178
Canarsie Bay, N. Y., improvement of	101	746		
Cane River, La., improvement of	230		1349	

SUBJECT.	Page.		
	Part I.	Part II.	Part III.
Caney Fork River, Tenn., improvement of	269		1523
Cape Ann, Mass., construction of harbor of refuge at Rockport	67	580	
Cape Fear River, N. C., improvement of, below Wilmington	168	1000	
Cape Fear River, N. C., improvement of, from Wilmington to Fayetteville	166	995	
Cedar Keys Harbor, Fla., improvement of	195	1148	
Cedar River, Mich., improvement at mouth of	293		1650
Channel between Staten Island and New Jersey, improvement of	110 788		
Charenton Canal, Saint Mary's Parish, La., improvement of	216	1259	
Charleston, S. C., defenses of	34		
Charleston Harbor, S. C., improvement of	176	1063	
Charlevoix Harbor, Mich., improvement of	309		1755
Charlotte Harbor, N. Y., improvement of	342		1887
Chattahoochee River, Ala. and Ga., improvement of	200	1168	
Cheboygan Harbor, Mich., improvement of	320		1824
Cheesequakes Creek, N. J., improvement of	106 763		
Chehalis River, Wash., improvement of	364		2009
Chesapeake Bay, removals of wrecks in	135	878	
Chester River, Md., at Kent Island Narrows, improvement of	130	866	
Chester River, Md., from Spry's Landing to Crumpton, improvement of	130	866	
Chicago Harbor, Ill., improvement of	306		1701
Chickahominy River, Va., improvement of	145	920	
Chippewa River, Wis., improvement of	258	1486	
Chippewa River at Yellow Banks, Wis., improvement of	259	1488	
Choctawhatchee River, Fla. and Ala., improvement of	203	1176	
Choptank River, Md., improvement of	131	868	
Cincinnati, Ohio, construction of ice harbor near	275		1549
Clearwater River, Idaho, improvement of Lower	360		1952
Cleveland Harbor, Ohio, improvement of	394		1863
Clinch River, Tenn., improvement of	268		1521
Clinton Harbor, Conn., improvement of	83 634		
Clinton River, Mich., improvement of entrance to	325		1842
Coanjok Bay, N. C., improvement of	154	965	
Cocheco River, N. H., improvement of	59 548		
Cohansey Creek, N. J., improvement of	122	847	
Colorado River, Cal. Nev. and Ariz., improvement of	356		1929
Columbia River, Oreg., construction of canal at the Cascades	358		1942
Columbia River, Oreg., defenses of	47		
Columbia River, Lower, Oreg., improvement of	357		1938
Columbia River, Oreg., improvement of mouth of	360		1971
Columbia River, Upper, and Snake River, Oreg., improvement of	359		1949
Columbia River, above mouth of Snake River, survey of	360		1953
Columbia River, Oreg., water-gauges on Lower	365		2010
Conecuh-Escambia River, Fla. and Ala., improvement of	203	1175	
Conneaut Harbor, Ohio, improvement of	338		1873
Connecticut River, above Hartford, Conn., improvement of	81 623		
Connecticut River, below Hartford, Conn., improvement of	82 625		
Contentnia Creek, N. C., improvement of	159	973	
Coosa River, Ala. and Ga., improvement of	200	1165	
Coosawattee River, Ga., improvement of	199	1165	

SUBJECT.	Page.			
	Part I.		Part II.	Part III.
Coos Bay, Oreg., improvement of entrance to	301			1999
Coquille River, Oreg., improvement of mouth of	362			2003
Corsica Creek, Md., improvement of	131		867	
Courtableau Bayou, La., improvement of	218		1263	
Cowlitz River, Wash., &c., improvement of	359			1951
Cumberland River, above the mouth of the Jellico, Ky., improvement of	267			1527
Cumberland River, Ky., South Fork of, improvement of	270			1535
Cumberland River, Tenn. and Ky., improvement of	266			1535
Cumberland Sound, Fla. and Ga., defenses of	37			
Cumberland Sound, Fla. and Ga., improvement of entrance to	189		1118	
Currituck Sound, improvement of	154		965	
Cypress Bayou, Tex. and La., improvement of	229		1347	
D.				
Dan River, Va. and N. C., improvement of	146		925	
D'Arbonne Bayou, La., improvement of	232		1356	
Davis Island, lock and dam, Ohio River, operating and care of	272			1540
Defenses of the northern frontier	5			
Defenses, sea-coast and lake frontier, general remarks on and estimates for	4			
Delaware Breakwater Harbor, improvement of	119		839	
Delaware Bay, construction of ice-harbor at head of	118		834	
Delaware Bay and River, removal of wrecks from	123		847	
Delaware River:				
between Trenton and its mouth, improvement of	113		801	
at Schooner Ledge, improvement of	115		828	
near Cherry Island Flats, improvement of	115		829	
Des Moines Rapids Canal, Mississippi River, operating and care of	254		1468	
Des Moines Rapids Canal, Mississippi River, dry dock at	254		1477	
Des Moines Rapids, Mississippi River, improvement at	253		1465	
Detroit River, Mich., improvement of	326			1860
Dorcheat Bayou, La., improvement of	230		1350	
Dry Tortugas Harbor, Fla., defenses at	39			
Dubuque, Iowa, improvement of harbor at	252		1424	
Dubuque, Iowa, ice-harbor at	252		1426	
Duck Creek, Del., improvement of	126		859	
Duck River, Tenn., improvement of	269			1538
Duluth Harbor, Minn., improvement of	287			1627
Dunkirk Harbor, N. Y., improvement of	338			1874
Duties and rank of officers of the Corps of Engineers	375			
E.				
Eagle Harbor, Mich., improvement of	291			1640
East Chester Creek, N. Y., improvement of	91	663		
East River, N. Y., removal of obstructions from	95	675		
Echo Harbor, New Rochelle, N. Y., improvement of	89	655		
Edenton Bay, N. C., improvement of	154		963	
Edisto River, S. C., improvement of	179		1082	
Elizabeth River, N. J., improvement of	110	785		
Elk River, W. Va., improvement of	281			1536
Engineer depot and post at Willets Point	52	471		
Engineers, battalion of	53	489		
Engineers, Board of, for Fortifications and for River and Harbor Improvements	48			
Engineers, School of Application at Willets Point, N. Y.	52	471		
Erie Harbor, Pa., improvement of	339			1879

SUBJECT.	Page.		
	Part I.	Part II.	Part III.
Escambia River, Ala., and Fla., improvement of	203	1175	
Estimates for surveys and examinations, and contingencies of rivers and harbors	365		
Explorations and reconnaissances in military divisions and departments	372		
Explorations and reconnaissances, estimates for, in military divisions and departments	373		
F.			
Fairport Harbor (Grand River), Ohio, improvement of	336		1868
Falls of Saint Anthony, Minn., preservation of	255	1479	
Falls of the Ohio River, improvement of, navigation at	276		1569
Feather River, Cal., improvement of	355		1926
Fernandina and Saint John's River, Fla., deepening the inside passage between	190	1124	
Fishways at Great Falls of Potomac River	368		2061
Flint River, Ga., improvement of	199	1162	
Flushing Bay, N. Y., improvement of	91 661		
Fort Brown, Tex., protection of river bank at	227	1336	
Fortifications, report of special board on	50 499		
Fox and Wisconsin rivers, improvement of	304		1686
Frankford Creek, Pa., improvement of	116	829	
Frankfort Harbor, Mich., improvement of	310		1737
French Broad River, N. C., improvement of	147	929	
French Broad River, Tenn., improvement of	268		1520
G.			
Galveston, Tex., defenses of	45		
Galveston Bay, ship channel in, improvement of	224	1322	
Galveston Harbor, Tex., improvement of entrance to	223	1291	
Gasconade River, Mo., improvement of	247	1396	
Gedney's Channel, New York Harbor, N. Y	98 724		
Georgetown and Washington harbors, D. C., improvement of	135	879	
Georgetown Harbor, S. C., improvement of	172	1027	
Goose Rapids, Red River of the North, Minn. and Dak.	262	1500	
Gowanus Bay, N. Y., improvement of	98 722		
Grand Haven Harbor, Mich., improvement of	314		1766
Grand Marais, Mich., harbor of refuge at	292		1646
Grand Marais, Minn., improvement of, harbor at	289		1637
Grand River, Mich., improvement of	314		1766
Grass River, N. Y., improvement of, at Massena	347		1898
Great Kanawha River, W. Va., improvement of	279		1589
Great Kanawha River, W. Va., construction of harbor of refuge at mouth of	275		1550
Great Pee Dee River, S. C., improvement of	169	1017	
Great Sodus Harbor, N. Y., improvement of	344		1890
Green Bay, Wis., improvement of harbor at	296		1658
Green Jacket Shoal, Providence River, R. I., removal of	75 605		
Greenport Harbor, N. Y., improvement of	90 658		
Guyandotte River, W. Va., improvement of	285		1622
H.			
Hampton Roads, Va., defenses of	30		
Harbor of refuge, Block Island, R. I., construction of	77 609		
Harbor of refuge, Bell River, Mich., construction of	324		1837
Harbor of refuge near Cincinnati, Ohio, construction of	275		1549
Harbor of refuge, Grand Marais, Mich	292		1646
Harbor of refuge, Great Kanawha River, W. Va., construction of	275		1549

Subject.	Page. Part I.	Page. Part II.	Page. Part III.
Harbor of refuge, Lake Pepin, Mississippi River, construction of	251	1422, 1494	
Harbor of refuge, Milwaukee Bay, construction of	301		1679
Harbor of refuge, Portage Lake, Lake Michigan, construction of	310		1758
Harbor of refuge, Sand Beach, Lake Huron	322		1829
Harbor of refuge, Sandy Bay, Cape Ann, Mass., construction of	67 580		
Harbor of refuge, Stonington, Conn., construction of	78 614		
Harbor of refuge, Sturgeon Bay Canal, Wis., construction of	296		1660
Harbor of refuge, Wood's Holl, Mass., construction of	69 591		
Harlem River, N. Y., improvement of	94 672		
Hay Lake Channel, Saint Mary's River, Mich., improvement of	318		1777
Hell Gate, N. Y., improvement of navigation at	95 675		
Hennepin Canal, additional surveys of	309		1706
Hiawassee River, Tenn., improvement of	267		1519
Horn Island Pass, Miss., improvement of	210	1206	
Housatonic River, Conn., improvement of	85 642		
Hudson River, N. Y., improvement of	92 665		
Humboldt Bay and Harbor, Cal., improvement of	353		1919
Huron Harbor, Ohio, improvement of	332		1856
Hyannis Harbor, Mass., improvement of	68 585		
I.			
Ice-harbor at Belle River, Mich., construction of	324		1837
Ice-harbor, near Cincinnati, Ohio, construction of	275		1549
Ice-harbor at head of Delaware Bay	118	834	
Ice-harbor at Dubuque, Iowa	252	1426	
Ice-harbor at Marcus Hook, Pa., construction of	117	832	
Ice-harbor at mouth of Muskingum River	274		1546
Ice-harbor at New Castle, Del	125	858	
Illinois River, improvement of	308		1705
Indian River, Del., improvement of	129	864	
Inland navigation from New Berne to Beaufort, N. C., improvement of	163	983	
Inside passage between Fernandina and Saint John's River, Fla., improvement of	190	1124	
J.			
James River, Va., improvement of	137	887	
Jetties at South Pass of the Mississippi River, inspection of	212	1225	
Jonesport, Me., improvement of Moos-a-bec Bar at	55 533		
K.			
Kanawha River, Great, improvement of	279		1539
Kanawaha River, Great, construction of harbor of refuge at mouth of	275		1550
Kanawha River, Little, improvement of	285		1623
Kennebec River, Me., defenses of	8		
Kennebunk River, Me., improvement of	57 543		
Kenosha Harbor, Wis., improvement of	303		1684
Kent Island Narrows, Md., improvement of	130	866	
Kentucky River, Ky., improvement of	282		1606
Kentucky River, Ky., operating and keeping in repair lock and dams on	283		1616
Kewaunee Harbor, Mich., improvement of	297		1663

SUBJECT.	Page.			
	Part I.		Part II.	Part III.
Keyport Harbor, N. J., improvement of	105	760		
Key West, Fla., defenses of	38			
Key West, Fla., improvement of harbor at	194		1144	
L.				
La Fourche Bayou, La., improvement of	219		1266	
La Grange Bayou, Fla., improvement of	204		1178	
Lake Bisteneau, La., improvement of	230		1350	
Lake City, Minn., construction of harbor of refuge at	251		1424	
Lake Huron, harbor of refuge on, at Sand Beach, Mich.	322			1829
Lakes, northern and northwestern, issue of charts of	371			
L'Anguille River, Ark , improvement of	243		1388	
Laws of Forty-ninth Congress, first session, affecting Corps of Engineers	395			
Leonardtown Harbor, Md., improvement of	140		901	
Lewes, Del., construction of piers at	118		836	
Little Harbor, at Portsmouth, N. H., improvement of	59			
Little Kanawha River, W. Va., improvement of	285			1623
Little Narragansett Bay, R. I., and Conn., improvement of	78	613		
Little Sodus Harbor, N. Y., improvement of	344			1891
Little Tennessee River, improvement of	270			1524
Loggy Bayou, La., improvement of	230		1350	
Louisville and Portland Canal, operating and maintaining	277			1574
Lower Clearwater River, Idaho, improvement of	360			1952
Lower Willamette and Columbia rivers, Oreg., improvement of	357			1938
Lubec Channel, Me., improvement of	54	527		
Ludington Harbor, Mich., improvement of	312			1761
Lynn Harbor, Mass., improvement of	65	577		
M.				
Malden River, Mass., improvement of	66	579		
Mamaroneck Harbor. N. Y., improvement of	90	657		
Manasquan River, N. J., improvement of	102	751		
Manatee River, Fla., improvement of	195		1150	
Manistee Harbor, Mich., improvement of	311			1759
Manistique Harbor, Mich., improvement of	293			1649
Manitowoc Harbor, Wis., improvement of	299			1667
Mantua Creek, N. J., improvement of	121		844	
Maps, military and geographical, preparation of	371			
Marcus Hook, Pa., improvement of ice-harbor at	117		832	
Marquette Harbor, Mich., improvement of	291			1645
Matagorda Bay, Tex., improvement of entrance to	225		1328	
Mattaponi River, Va., improvement of	143		915	
Mattawan Creek, N. J., improvement of	105	761		
Maurice River, N. J., improvement of	124		855	
Meeker's Island, Minn., lock and dam at	257		1485	
Meherrin River, N. C., improvement of	155		965	
Menomonee Harbor, Mich. and Wis., improvement of	294			1652
Merrimac River, Mass., improvement of	61	560		
Michigan City Harbor, Ind., improvement of	316			1774
Military and geographical maps printed	371			
Milford Harbor, Conn., improvement of	85	640		
Milwaukee Bay, construction of harbor of refuge at	301			1679
Milwaukee Harbor, Wis., improvement of	302			1680
Minnesota River, Minn., improvement of	260		1494	
Mispillion Creek, Del., improvement of	127		861	
Mississippi (Lower) and Missouri rivers, operations of snag-boats on	244			1393

Subject.	Page.		
	Part I.	Part II.	Part III.
Mississippi River:			
above Falls of Saint Anthony, improvement of	256	1483	
at Des Moines Rapids, improvement of	253	1465	
at Dubuque, Iowa, improvement of	252	1424	
at Falls of Saint Anthony, improvement of	255	1479	
at Lake Pepin, construction of harbor of refuge	251	1422, 1424	
at Meeker's Island, Minn., construction of lock and dam	257	1485	
at Rock Island Rapids, improvement of	252	1427	
between the mouths of the Illinois and Ohio rivers, improvement of	249		
from Des Moines Rapids to mouth of Illinois River, improvement of	249, 251	1422	
from Saint Paul to Des Moines Rapids, improvement of	250	1412	
improvement of South Pass, inspection of	212	1225	
reservoir at sources of	363	1501	
snag-boats on, operations of	244	1393	
Upper, operations of snag-boats on	250	1403	
water-gauges on	237	1368	
Mississippi River Commission, report of	247		2143
Mississippi Sound, defense of	42		
Missouri River:			
between Sioux City and Fort Benton, improvement of	248		
snag-boats on, operations of	245	1394	
Missouri River Commission, report of	248		2167
Mobile, Ala., defenses of	41		
Mobile Harbor, Ala., improvement of	205	1183	
Mokelumne River, Cal., improvement of	355		1924
Monongahela River, improvement of	273		1542
Monongahela River, operating and care of lock and dam No. 9	273		1543
Monroe Harbor, Mich., improvement	326		1847
Moose-a-bec Bar, Jonesport, Me., improvement of	55 533		
Mount Vernon, Va., improvement of channel at	139	899	
Movable dam at Davis Island, Ohio River	272		1540
Muscle Shoals Canal, Tennessee River, construction of	265		1510
Muskegon Harbor, Mich., improvement of	313		1764
Muskingum River, construction of ice-harbor at	274		1546
Muskingum River, Ohio, improvement of	274		1547
Muskingum River, Ohio, examination and survey of	276		1551
N.			
Nantucket Harbor, Mass., improvement of	68 587		
Narragansett Bay, defenses of	14		
Narragansett Bay, R. I., improvement of	74 602		
Neabsco Creek, Va., improvement of	140	901	
Neches River, Tex., improvement of	222	1288	
Neuse River, N. C., improvement of	162	979	
New Bedford, Mass., defenses of	14		
New Berne and Beaufort, N. C., inland navigation between, improvement of	163	983	
Newburyport Harbor, Mass., improvement of	60 557		
New Castle, Del., ice-harbor at	125	858	
New Haven Harbor, Conn., construction of breakwater at	84 639		
New Haven Harbor, Conn., defenses of	17		
New Haven Harbor, Conn., improvement of	84 636		
New London Harbor, Conn., defenses of	15		
New London Harbor, Conn., improvement of	83 632		
New Orleans, La., defenses of	42		

SUBJECT.	Page.			
	Part I.		Part II.	Part III.
Newport Harbor, R. I., improvement of	75	606		
New River, N. C., improvement of	165		991	
New River, Va., and W. Va., improvement of	281			1599
New Rochelle Harbor, N. Y., improvement at	89	654		
Newtown Creek, N. Y., improvement of	96	717		
New York Harbor, defenses of	17			
New York Harbor, Gedney's Channel in, improvement of	98	724		
Niagara River, N. Y., improvement of	341			1884
Nomini Creek, Va., improvement of	141		903	
Nooksack River, Wash., improvement of	364			2007
Norfolk Harbor, Va., and its approaches, improvement of	148		951	
Northern frontier, defenses of	5			
Northern and Northwestern Lakes, issue of charts of	371			
North Landing River, Va., and N. C., improvement of	153		962	
North River Bar, Currituck Sound, N. C., improvement of	154		965	
Norwalk Harbor, Conn., improvement of	88	649		
Nottaway River, Va., improvement of	151		961	
Noxubee River, Miss., improvement of	208		1201	
O.				
Oakland Harbor, Cal., improvement of	350			1907
Oak Orchard Harbor, N. Y., improvement of	342			1886
Obstructions to navigation, remarks on removal of	81	619		
Ocmulgee River, Ga., improvement of	198		1159	
Oconee River, Ga., improvement of	198		1161	
Oconto Harbor, Wis., improvement of	294			1653
Office of the Chief of Engineers	374			
Officers of the Corps of Engineers, number of duties of	3			
Ogdensburg Harbor, N. Y., improvement of	346			1895
Ohio River, construction of ice-harbor, near Cincinnati	275			1549
Ohio River, Davis Island lock and dam	272			1540
Ohio River, improvement of Indiana Chute at Falls of	276			1572
Ohio River, improvement of	271			1528
Ohio River, improvement of falls of	276			1569
Olcott Harbor, N. Y., improvement of	341			1885
Old Town Creek, Miss., improvement of	208		1200	
Ontonagon Harbor, Mich., improvement of	290			1641
Oostenaula River, Ga., improvement of	199		1165	
Osage River, Mo. and Kans., improvement of	246		1395	
Oswego Harbor, N. Y., improvement of	345			1892
Otter Creek, Vt., improvement of	350			1905
Ouachita River, La. and Ark., improvement of	230		1351	
P.				
Pamplico River, N. C., improvement of	156		966	
Pamunky River, Va., improvement of	144		917	
Pascagoula River, Miss., improvement of	209		1203	
Pascagoula River, Miss., from Moss Point to anchorage in bay, examination and survey of	211		1215	
Passaic River, N. J., above Newark, improvement of	111	793		
Passaic River, N. J., below Newark, improvement of	112	797		
Pass Cavallo Inlet, Tex., improvement of	225		1328	
Patapsco River, Md., improvement of	133		874	
Pawcatuck River, R. I., improvement of	80	616		
Pawtucket River, R. I., improvement of	73	598		
Pearl River, Miss., improvement of, between Edinburg and Carthage	211		1214	

SUBJECT.	Page.		
	Part I.	Part II.	Part III.
Pearl River, Miss., improvement of, below Jackson....	210	1207	
Pearl River, Miss., improvement of, from Jackson to Carthage	210	.1212	
Pease Creek, Fla., improvement of	195	1146	
Pee Dee River, Great, S. C., improvement of	169	1017	
Penobscot River, Me., defenses of....................	7		
Penobscot River, Me., improvement of................	55 530		
Pensacola Harbor, Fla., defenses of...................	40		
Pensacola Harbor, Fla., improvement of...............	204	1179	
Pensaukee Harbor, Mich., improvement of..............	295		1656
Pentwater Harbor, Mich., improvement of.............	312		1762
Philadelphia Advisory Harbor Commission.............	123	849	
Philadelphia, Pa., defenses of........................	25		
Pier at Lewes, Del., construction of..................	118	836	
Plattsburg Harbor, N. Y., improvement of............	348		1902
Plymouth Harbor, Mass., improvement of.............	64 571		
Portage Lake, Mich., construction of harbor of refuge at	310		1758
Port Chester Harbor, N. Y., improvement of..........	88 651		
Port Clinton Harbor, Ohio, improvement of...........	329		1854
Port Jefferson Harbor, L. I., N. Y., improvement of ...	90 660		
Portland Harbor, Me., defenses of.....................	8		
Portland Harbor, Me., improvement of...............	57 538		
Portsmouth Harbor, N. H., defenses of...............	10		
Portsmouth Harbor, N. H., improvement of...........	58, 546, 541		
Port-warden's line at Philadelphia	123	849	
Port Washington Harbor, Wis., improvement of......	300		1672
Post and depot at Willets Point	52 471		
Potomac River, improvement of, in vicinity of Washington, D. C..	136	881	
Potomac River, fish-ways at Great Falls of............	368		2061
Potomac River at Mount Vernon	139	899	
Providence River, R. I., improvement of..............	74 602		
Provincetown Harbor, Mass., improvement of..........	65 574		
Public buildings and grounds, District of Columbia....	368		2075
Pultneyville Harber, N. Y., improvement of...........	343		1889
R.			
Raccoon River, N. J., improvement of..................	121	844	
Racine Harbor, Wis., improvement of	302		1682
Rahway River, N. J., improvement of	109 783		
Rancocas River, N. J., improvement of	120	841	
Rank and duties, officers of Engineers	375		
Rappahannock River, Va., improvement of...........	142	906	
Raritan Bay, N. J., improvement of	106 765		
Raritan River, N. J., improvement of..................	107 769		
Reconnaissances and explorations and estimates for...	372		
Red River, La., improvement of.......................	227	1337	
Red River of the North, improvement of..............	261	1496	
Red River of the North, construction of lock and dam at Goose Rapids	262	1500	
Redwood Harbor, Cal., improvement of	352		1914
Reservoirs at sources of the Mississippi River and its tributaries, construction of..............................	263	1501	
Reservoirs at sources of the Mississippi River and its tributaries, surveys for..................................	264	1507	
Rio Grande, Tex., protection of river banks at Fort Brown	227	1336	
River and harbor improvements........................	53		
Roanoke River, N. C., improvement of	147	927	
Rock Island Rapids, Mississippi River, improvement at.	252	1427	
Rockland Harbor, Me., improvement of...............	56 536		
Rocky River, Ohio, improvement of....................	334		1862

Subject.	Page. Part I.	Page. Part II.	Page. Part. III.
Romerly Marsh, Ga., improvement of water-route through	185	1102	
Rondout Harbor, N. Y., improvement of	94 670		
Rouse's Point, N. Y., construction of breakwater at	348		1899
S.			
Sabine Pass, Tex., improvement of	221	1278	
Sabine River, La. and Tex., improvement of	222	1287	
Sackett's Harbor, N. Y., improvement of	346		1894
Saco River, Me., breakwater at mouth of	58 546		
Saco River, Me., examination and survey of	60 552		
Sacramento River, Cal., improvement of	355		1926
Saginaw River, Mich., improvement of	322		1826
Saint Anthony, preservation of Falls of	255	1479	
Saint Augustine Creek, Ga., improvement of	185	1102	
Saint Augustine, Fla., defenses of	38		
Saint Clair Flats Ship-canal, Mich., repairs of	324		1837
Saint Clair Flats Ship-canal, Mich., operating and care of	325		1838
Saint Croix River, Wis. and Minn., improvement of	259	1490	
Saint Francis River, Ark., improvement of	242	1382	
Saint Jerome's Creek, Md., improvement of harbor at	141	904	
Saint John's River and Fernandina, Fla., deepening inside passage between	1	1124	
Saint John's River, Fla., improvement of bar at mouth of	190	1125	
Saint John's River, Fla., Upper, improvement of	191	1133	
Saint Jones River, Del., improvement of	126	860	
Saint Joseph's Harbor, Mich., improvement of	316		1771
Saint Mary's Falls Canal and Saint Mary's River, Mich., improvement of	319		1783
Saint Mary's Falls Canal, Mich., dry-dock at	320		1823
Saint Mary's Falls Canal, Mich., operating canal at	319		1809
Saint Mary's River, Mich., improvement of Hay Lake Channel	318		1777
Salem River, N. J., improvement of	122	846	
Saline River, Ark., improvement of	243	1367	
Salkiehatchie River, S. C., improvement of	180	1084	
Sand Beach, Mich., Lake Huron, harbor of refuge at	322		1829
San Diego, Cal., defenses of	45		
San Diego Harbor, Cal., improvement of	353		1917
Sandusky City Harbor, Ohio, improvement of	330		1855
Sandusky River, Ohio, improvement of	331		1857
Sandy Bay, Cape Ann, Mass., harbor of refuge at	67 580		
San Francisco, Cal., defenses of	45		
San Francisco Harbor, Cal., removal of wreck from	352		1915
San Joaquin River, Cal., improvement of	354		1921
Santee River, S. C., improvement of	173	1030	
Saugatuck Harbor, Mich., improvement of	315		1769
Saugerties Harbor, N. Y., improvement of	93 669		
Savannah, Ga., defenses of	36		
Savannah River and Harbor, Ga., improvement of	181	1087	
Savannah River, Ga., above Augusta, improvement of	184	1100	
Savannah River, Ga., below Augusta, improvement of	183	1098	
School of Application, Battalion of Engineers	53 489		
Schuylkill River, Pa., improvement of	116	830	
Scituate Harbor, Mass., improvement of	62 562		
Scuppernong River, N. C., improvement of	158	969	
Sea-coast and lake frontier defenses, general remarks on and estimates for	4		

Subject.	Page. Part I.	Page. Part II.	Page. Part III.
Sheboygan Harbor, Wis., improvement of	299		1670
Sheepshead Bay, N. Y., improvement of	100 743		
Shenandoah River, Va. and W. Va., improvement of	139	891	
Shrewsbury River N. J., improvement of	103 756		
Skagit River, Wash., improvement of	364		2007
Snag-boats on the Arkansas, operations of	238	1371	
Snag-boats on the Lower Mississippi and Missouri, operations of	244	1393	
Snake River, Wash., improvement of	359		1949
Snohomish River, Wash., improvement of	364		2007
Snoqualmie River, Wash., improvement of	364		2007
Sodus Harbor, N. Y., Great, improvement of	344		1890
Sodus Harbor, N. Y., Little, improvement of	344		1891
South Forked Deer River, Tenn., improvements of	237	1367	
South Haven Harbor, Mich., improvement of	315		1770
South Pass, Mississippi River, inspection of improvement at	212	1225	
Southport Harbor, Conn., improvement of	87 648		
South River, N. J., improvement of	108 777		
Staten Island, N. Y., improvement of New Jersey Channel	110 788		
Staunton River, Va., improvement of	145 146	922, 924	
Steele's Bayou, Miss., improvement of	235	1363	
Steilaquamish River, Wash., improvement of	364		2007
Stockholm, Wis., construction of harbor of refuge at	251	1422	
Stonington Harbor, Conn., improvement of	78 614		
Sturgeon Bay Canal, Wis., harbor of refuge at	296		1660
Sumpawanus Inlet, L. I., N. Y., improvement of	102 748		
Sunflower River, Miss., improvement of	234	1359	
Superior Bay, Wis., improvement of	288		1632
Survey of Northern and Northwestern lakes, issue of charts of	371		
Surveys and examinations for improvement of rivers and harbors, estimates for	365		
Surveys, additional, for Hennepin Canal	309		1708
Susquehanna River, near Havre de Grace, Md., improvement of	129	864	
Suwanee River, Fla., improvement of	194	1143	
Swanton Harbor, Vt., improvement of	348		1901
T.			
Tallahatchie River, Miss., improvement of	234	1361	
Tallapoosa River, Ala., improvement of	201	1172	
Tampa Bay, Fla., improvement of	192	1137	
Tampa Bay, Fla., removal of wreck from	199	1159	
Tangipahoa River, La., improvement of	213	1241	
Tar River, N. C., improvement of	156	966	
Taunton River, Mass., improvement of	72 595		
Tchefuncte River, La., improvement of	214	1242	
Tchula Lake, Miss., improvement of	234	1360	
Teche Bayou, La., connection with Grand Lake, at Charenton	216	1259	
Teche Bayou, La., improvement of	215	1245	
Tennessee River, above Chattanooga, improvement of	264		1509
Tennessee River, below Chattanooga, improvement of	265		1510
Tennessee River, Little, improvement of	270		1524
Tensas River, La., improvement of	232	1355	
Terrebonne Bayou, La., improvement of	219	1264	
Tickfaw River, La., improvement of	215	1244	
Thames River, Conn., improvement of	82 629		
Thunder Bay Harbor, Mich	321		1825
Ticonderoga River, N. Y., improvement of	350		1906

SUBJECT.	Page.		
	Part I.	Part II.	Part III.
Toledo Harbor, Ohio, improvement of	327		1849
Tombigbee River, Ala., improvement of	206	1196	
Torpedo defense	50		
Totusky River, Va., improvement of	142	913	
Tradewater River, Ky., improvement of	284		1617
Trent River, N. C., improvement of	160	976	
Trinity River, Tex., improvement of	224	1323	
Two Rivers Harbor, Wis., improvement of	298		1665
U.			
Umpqua River, Oreg., improvement of	363		2005
Upper Columbia and Snake rivers, Oreg. and Wash., improvements of	359		1949
Upper Mississippi River, operations of snag-boats on	250	1403	
Upper Thoroughfare, Deal's Island, and main	132	870	
Upper Willamette River, Oreg., improvement of	258		1940
Urbana Creek, Va., improvement of	143	914	
V.			
Vermillion Harbor, Ohio, improvement of	332		1859
Volusia Bar, Lake George, Fla., improvement of	192	1135	
W.			
Wabash River, Ind., improvement of	277		1582
Waccemaw River, N. C., improvement of	170	1022	
Wachita River, Ark. and La., improvement of	230	1351	
Wacissa River, Fla., examination and survey of	212	1220	
Wappoo Cut, S. C., improvement of	178	1077	
Wareham Harbor, Mass., improvement of	70 593		
Warren River, R. I., improvement of	75 605		
Warrior River, Ala., improvement of	206	1193	
Washington Aqueduct, D. C	365		2013
Washington, D. C., defenses of	29		
Washington and Georgetown harbors, D. C., improvement of	135	879	
Washington, D. C., improvement of Potomac River at	136	881	
Washington, D. C., increasing water supply of	366		2021, 2043
Wateree River, S. C. improvement of	174	1053	
Water-gauges on Mississippi River and its tributaries	237	1368	
Water-gauges on Columbia River, Oreg., and tributaries	365		2010
Waukegan Harbor, Ill., improvement of	303		1685
Westport Harbor, Mass., improvement of	70 592		
White River, Ark., improvement of	240	1378	
White River, Ark., above Buffalo Shoals, improvement of	241	1381	
White River Harbor, Mich., improvement of	313		1763
White River, Ind., improvement of	279		1586
Wicomico River, Md., improvement of	132	869	
Willamette River, Lower, Oreg., improvement of	357		1938
Willamette River, Upper, Oreg., improvement of	358		1940
Willets Point, N. Y., engineer post and depot at	53 489		
Wilmington Harbor, Cal., improvement of	351		1911
Wilmington Harbor, Del., improvement of	124	857	
Wilmington, N. C., defenses of	34		
Wilson Harbor, N. Y., improvement of	341		1885
Wisconsin and Fox rivers, improvement of	304		1686
Withlacoochee River, Fla., improvement of	197	1155	
Woodbridge Creek, N. J., improvement of	109 781		

SUBJECT.	Page.		
	Part I.	Part II.	Part III.
Woodbury Creek, N. J., improvement of	121	843	
Wood's Holl Harbor, Mass., improvement of	69 591		
Wrecks in Cape Fear River, removal of	175	1060	
Wrecks in Chesapeake Bay, removal of	135	878	
Wrecks in Delaware Bay and River, removal of	123	847	
Wrecks in Fairport Harbor, Ohio, removal of	339		1876
Wrecks in New Orleans Harbor, La., removal of	223	1290	
Wrecks in North Carolina and Virginia, removal of	159	970	
Wreck in San Francisco Harbor, Cal., removal of	352		1915
Wreck in Scuppernong River, N. C., removal of	159	970	
Wreck in Tampa Bay, Fla., removal of	197	1157	
Wrecks off Cape Cod, removal of	80 618		
Wreck off entrance to Narragansett Bay	81 619		
Y.			
Yadkin River, N. C., improvement of	157	967	
Yalabusha River, Miss., improvement of	235	1362	
Yaquina Bay, Oreg., improvement of entrance to	362		1998
Yazoo River, Miss., improvement of	233	1357	
Yellowstone River, improvement of	249	1399	
York River, Va., improvement of	144	918	